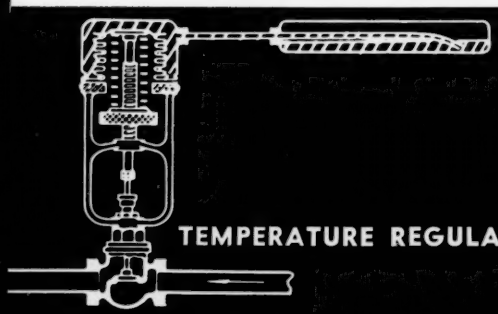
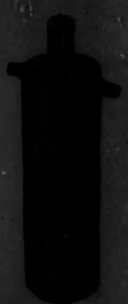
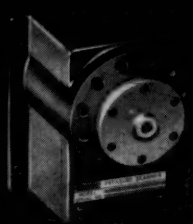
INSTRUMENTS and AUTOMATION



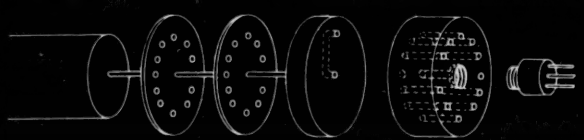
TEMPERATURE REGULATORS



MACHINE TOOL CONTROL



PRESSURE SCANNER



AUGUST 1957

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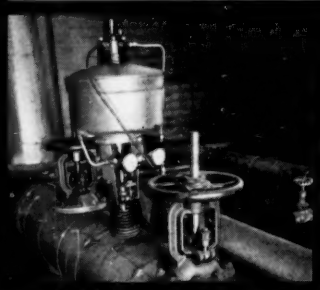
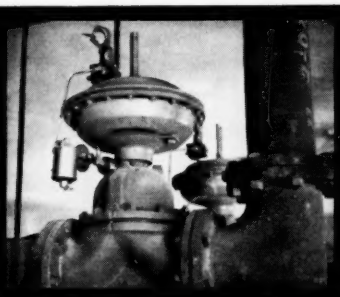
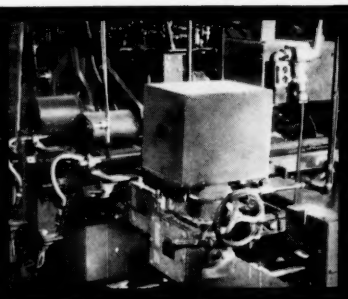
by CONOCONTROLS Specialists



Conoflow LB Valve on a difficult liquid level control job in a Barrett Div. plant of Allied Chemical & Dye Corp. This valve is handling hot coal tar at temperatures to 750° F.

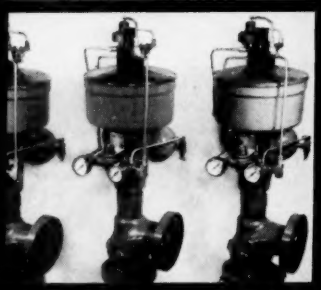


Conoflow Saunders Valves used in conjunction with Fuller Company's Airveyor System in a midwestern cement plant. These close-coupled "on-off" valves are equipped with solenoids and armored position indicators.



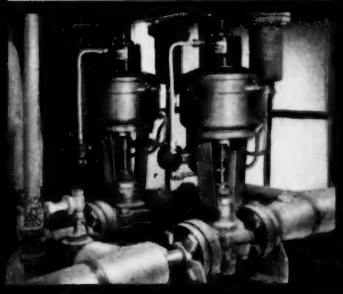
One of several Conoflow Rotomotors on a unique service in Owens-Corning's Newark, Ohio plant. This powerful pneumatic actuator positions a large circular saw which automatically trims and cuts a continuous sheet of Fiberglas into stock widths.

Conoflow Pressure Transmitters for the Kraft Foods Company. They will be used with miniature recorder-controllers to give visual indication and record of levels and pressures in vegetable oil vessels.

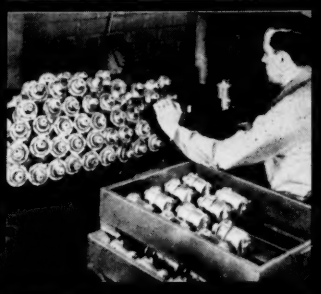


These 3" Conoflow "S" Valves are going to the Aluminum Co. of America in the new St. Louis pilot plant. They will be handling hot flashing caustic liquor containing 7% suspended solids with pressure drops up to 300 psi.

Cylinder Conomotor affords remote manual or automatic adjustment of flow rate for a Kates direct-acting flow regulator. This is one of many OEM applications for Conoflow's versatile pneumatic throttling actuator.



These Conoflow LB Valves have been on a tough temperature control service for over three years in the plant of this large manufacturer of floor covering and insulation. More than 600 Conoflow LB Valves are in use throughout this plant.



Conoflow Airpak filter-regulators being tested prior to shipment to duPont. Other large volume Airpak users are: Phillips Petroleum, Leeds & Northrup, Catalytic Construction, Minneapolis-Honeywell, and Fischer & Porter.

While most Conoflow products are shelf items—a good many are not. They are created for the job through our engineering and yours—combined and concentrated on your problem. Shown above are only a few examples of the variety and scope of Conoflow installations. If you are not already a Conoflow customer, phone or write us at 2100 Arch Street, Philadelphia 3, Pa. We'll put you in touch with a Conoflow representative qualified to help you.

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• • •

For detailed technical data on the new GEDA A-14 Automatic Stabilization System, ask for your personal copy of the paper: "A Reliable Method Of Drift Stabilization And Error Detection In Large-Scale Analog Computers."

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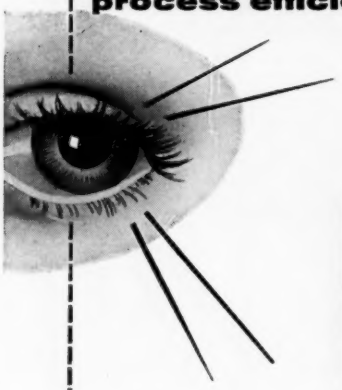

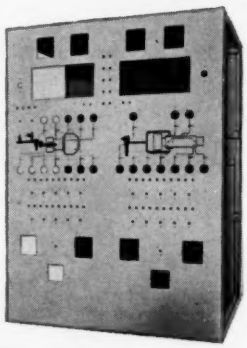

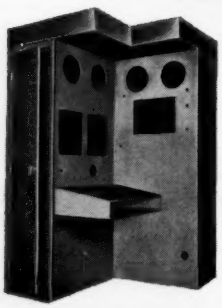

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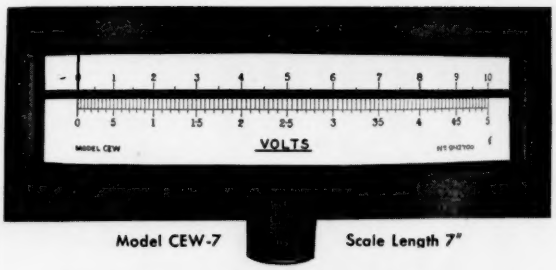

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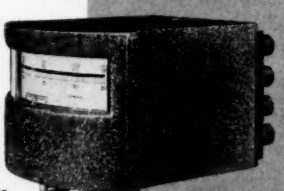

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INSTRUMENTS and AUTOMATION

Volume 30, No. 8
August 1957

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SPECIAL FEATURE

Preview of the 12th Annual I.S.A. Show 1522

EDITORIAL

Needed: Better Program Management! 1475
Mechanization vs Automation 1475
Help! 1476

FEATURE ARTICLES

Temperature Regulators 1479
C. S. Beard

Pneumatic or Electronic Control 1484
Harold W. Alyea

Pressure Control by Cartesian Diver 1486
Roger Gilmont, Isadore Gepner, Bernard Hanlon, Earl Hitchcock and Donald Salmon

Checking Circuits and Diagnostic Routines 1491
J. Presper Eckert, Jr.

Electronic Circuitry 1494
Milton H. Aronson and Charles F. Kezer

Automation In Airframe Production 1496

Multi-Pressure Scanner 1498
Robert J. Marmorstone

Instrumentation⇌Education 1501

Commerce Department I.G.Y. Instrumentation 1502

High-Speed High-Pressure Gage 1504
P. L. Edwards

Journal of the Southern California Meter Association

Principles and Use of Orifice-Meter Coefficients 1508
Russell D. Wood

The Simulation Council Newsletter 1515

Other Regular Features

Letters to the Editor	1400	Panhandle Pete	1469
Inquiries	1401	New Instruments	1545
Events	1407	Briefs	1594
Trends	1415	New Literature	1604
News	1416	Searchlite Section	1618
Books	1426	Advertiser's Index	1620
Biographies of Significance	1467	Inquiry Card	1621

THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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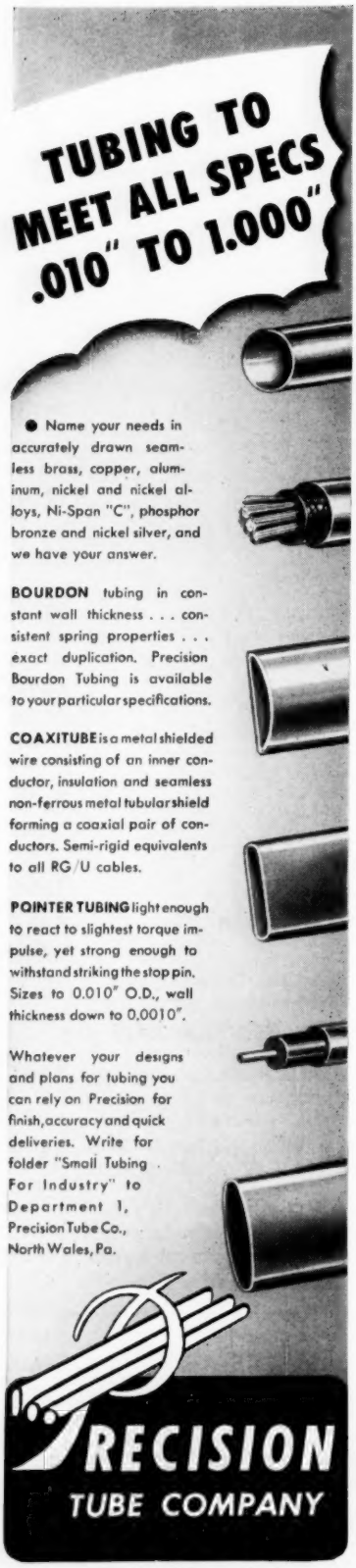
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Letters to the editor

Editor, I&A:

A reprint of your editorial of March 1957 in *Instruments and Automation* entitled, "Systems Engineering and the Instrument Manufacturer" has just come to my attention.

Heaven only knows that we, as a prominent magnetic tape recorder equipment manufacturer, have been trying to say the same thing for a long period of time, but I am afraid you have done a much better job of summing up our own opinion.

It is to be hoped that the instrument manufacturers everywhere will take your editorial to heart and concentrate first on doing the best possible job in the area in which they have the greatest contribution to make to our technology and our general welfare.

John Jipp
Mgr., Inst. Div.
Ampex Corp.
Redwood City, Calif.

Editor, I&A:

With reference to your March editorial (page 445) titled, "Systems Engineering and The Instrument Manufacturer," we have a question and some notions for debate.

When is a system not a system? *When it is a feedback component of a larger process.*

Instrument systems are rarely complete operating entities. They usually are an accessory to much greater systems such as a missile, a chemical plant or a light and power company. In this sense, even the most extensive data sensing, processing, recording and control instrument system represents a rather small fraction of the larger system in which it is a sophisticated component.

Particularly where non-linearity or backlash occurs in a process or control system, it is necessary to properly distribute correcting and/or compensating elements throughout the data system for maximum performance at lowest cost.

Thus looking at the data system as merely a component of some much larger process system, it appears that the transducer manufacturer is merely doing applications engineering when he designs or chooses elements to couple his transducers to the control point of the overall process.

Interaction aspects of transducers, computers, indicators and controllers often require experience and testing facilities beyond the scope of some customers or consultants.

Catalog and MIL specifications characteristically include conservative boundary margins to cover production tolerances, user optimism and unstandardized test procedures.

Only the component manufacturer knows how to obtain maximum performance by conditional excursions beyond published specification boundaries so that errors are minimized or compensated.

We are selling sophistication as the primary element in Automation Instruments. Sophistication requires advanced taste. It also requires a unity of design that goes far beyond the dress and hat. It always extends to the shoes and accessories and may become involved with boundary problems of less visible elements.

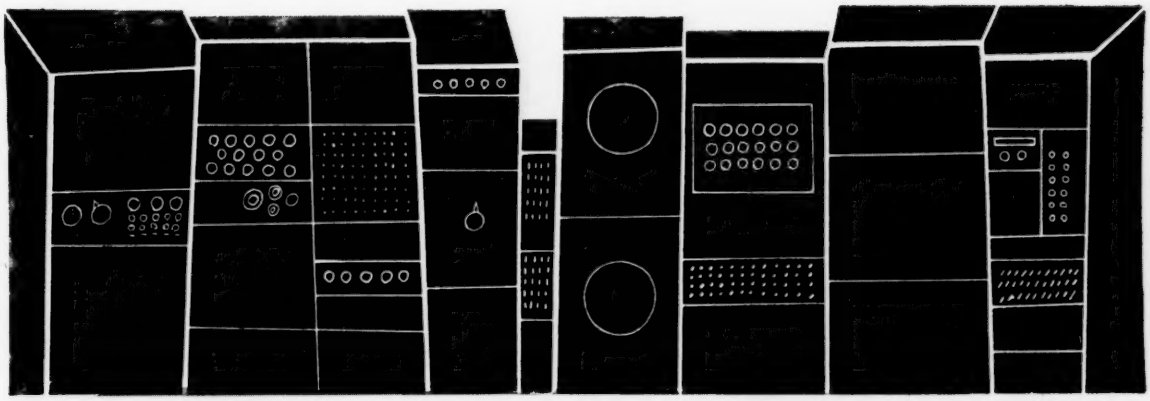
J.N.A. Hawkins
Special Ass't. to the Vice President
BJ Electronics
Borg-Warner Corp.
Santa Ana, Calif.

This debate on a basic question is becoming the important question of our time in the automation field. Most persons will agree that systems engineering requires knowledge of—and access to—the complete system and all its elements. Bearing in mind that (1) practically all profit to date in our field has resulted from sales of hardware, and that (2) consultation and services associated with hardware sales have always been loss items for instrument manufacturers in the past, the question becomes one of whether it is economic for instrument manufacturers to perform systems engineering consultation—and whether such consultant-type service is economic for industry today. An early issue of *I&A* will be a special issue devoted to this question.

Editor, I&A:

I am in the process of organizing a training program for pneumatic instrumentation. Although engaged in this work for years, we have not done very much about training our men on the subject; we have had some success with two vocational schools who work with our local unions (I am member of the United Association of

simple as a desk calculator...



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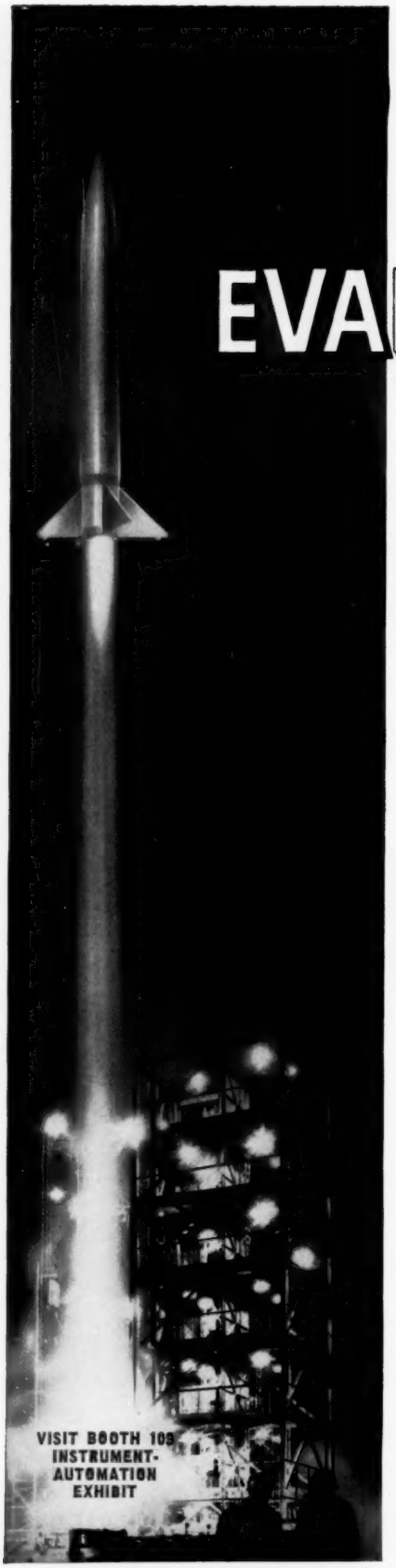

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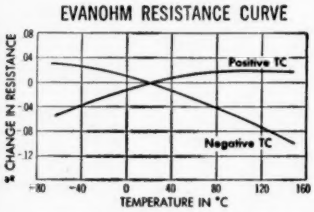

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LETTERS—CONTINUED

the Piping Industry).

I would like to lecture our group on the size of the pneumatic instrument industry. Can you give me an intelligent estimate?

C. F. Day
Antioch, Calif.

Please refer to the economic survey in our June issue. Pneumatic instruments would appear in classifications 3821-331, -341, -398, and -511. These total up to $432 million in 1954—and probably increased to $500 million in 1956. Perhaps 10-15% of this total is pneumatic. This places the pneumatic instrument market at $60 to $90 million annually.

Editor, I&A:

Hats off again for your devotion to the cause of public education via your recent editorial! It is indeed good to find men with such foresight who give voice to the only cause through which we may build for a stronger and greater nation. I am happy to be a reader of such a publication as you edit in *Instruments and Automation.*

Onni E. Kangas
Knoxville 17, Tennessee

Editor, I&A:

Thanks very much for your nice letter and helpful list of motion pictures. We appreciate your service in compiling this list. It, too—like *Instruments and Automation*—is helpful!

Fred M. Crandall
Ball Brothers Co., Inc.
Muncie, Ind.

We maintain a complete list of motion pictures on instrumentation subjects.

Editor, I&A:

Your editorial comment elicits my warm commendation of your efforts to encourage precise and lucid use of English . . . I think your brand of English is good and needs to be emulated by many "muddy" authors.

Allen Huntington
La Canada, Calif.

Editor, I&A:

I am sympathetic to the many important points in your May editorial and the economic realities underlying them.

Harry Gold
New York 18, N. Y.

Editor, I&A:

The subject series in *Instruments and Automation* by Messrs. Klein, Williams and Morgan have been attracting my utmost attention and interest since its first part appeared in Volume 28 No. 10, Oct 1956.

I am an instructor in the management field and have great interest in Automation.

Believing that the subject series are excellent work and useful as instructing materials for managerial personnel and production engineers, I wish to translate the series and publish them in Japanese, and ask your permission to do so.

Fumishisa Ichikawa
Kitatamagun, Tokyo

Permission granted. This work is being translated into German also.

Reader Inquiries

Electro-sensitive Chart Paper

Medical professor at university asks for sources of supply of electro-sensitive chart papers for oscillographs. A-253

Silver for Decade Switches

Reader is anxious to get information on types of silver used for electrical decade switches. A-254

Automatic Character Scanning

University professor (management) is interested in information on technical developments in automatic character scanning and recognition, and applications. A-255

Steam Quality Measurement

Belgian consulting engineering firm seeks information on method to determine moisture content of steam (½ kg/cm² press. 120 to 130°C temp.) by pressure measurement with nozzle and reference to tables. A-256

Market Place

Australian Representative

Large aggressive representative of instruments in the Australian Commonwealth, already handling several lines for about three years, desires contact with other American manufacturers seeking representation in **Australia, especially scientific testing** and gaging instruments. Write to Market Place c/o Instruments Publishing Company, 845 Ridge Ave., Pittsburgh 12, Pa.

RAMBLINGS ON INSTRUMENTATION

Melvin Rides Again!

Our man Melvin, one of Hays' lovable service engineers, turns in call reports that occasionally border on the supernatural. However, he invariably sticks to the facts when talking about Hays products. Which is all we'll vouch for in his latest report. Here it is:

HAPPY HARBOR MOTEL
Happy Harbor, Michigan

Dear Captain Bligh:

Due to a series of circumstances that would shrivel a lesser man, I am temporarily detained in this dreary outpost on Route 117A. I received your rather stiffly worded wire yesterday and gather there has been some question as to my whereabouts. I'm sure that when I tell you what I've been doing, you'll agree that old Melvin has been hitting the old ball for Hays as hard as ever.

As you know I came up here to take delivery on my new car and it occurred to me that I might check up on a few of the many Hays installations here in the Motor City (figuring the company would be glad to take care of the few additional expenses involved).

One of our Electronic Mercuryless Flow Meters has been in service in a foundry of one of the Big Three auto companies for some time and I dropped over to see how it was operating. If I were you, I'd keep the following information under wraps because if our engineering department gets wind of it they'll want a raise en masse.

Seems the foundry uses this instrument for measuring oxygen flow in a scarfing operation, a process for cutting scale off forgings with an oxy-acetylene torch.

So far as maintained accuracy over a long period of time is concerned, the folks in this foundry rank their Hays meter right after the sun and the moon. Get this . . . after two full years of service there have been no tubes changed in the amplifier, no change in the original calibration as shown by the water column calibration check they give it every three months, and it has never exceeded one percent in integrator error when compared with planimeter checks of the chart.

On the performance of this one meter, this mammouth outfit is specifying Hays meters . . . period. Nine more flow meters and remote indicating receivers have been ordered this month. More to come.

Not wishing to bother a busy executive like yourself with trivia, I am enclosing my expense account in what you might call broad, outline form. I'm sure you'll agree the expense is well justified, even though this was not, strictly speaking, a business trip.

Matter of fact, I'd appreciate it if you could have a modest advance wired to me here at Happy Harbor so I can ransom my luggage from the curmudgeon who runs this air conditioned cell block. Apparently he's never heard of credit cards!

Urgently yours,
Melvin

More on the Universal Recorder

In last month's Ramblings we "leaked" some advance information on the new Hays Universal Recorder in an attempt to whet your appetite for same. Now it can be told that this surprisingly versatile instrument will be unveiled at the ISA show in September.

If you're the type that lies awake nights thinking about The Ideal Recorder (and who doesn't ?), this sleek new Hays product may enable you to get more sleep. Try to visualize an instrument of four quadrant construction with the following combinations of receivers:

4 Slidewires—resistance or potentiometer type with 2 alarm switches and 1 retransmitting slidewire;

4 Differential transformers — Hays-design 3-wire system with 3 limit switches and 2 retransmitting slidewires;

2 Integrators—continuous mechanical type; or . . . 4 direct actuated pens —pressure or temperature (2 per quadrant).

A possible one-instrument combination might be a steam flow pen with 2 alarm switches and a slidewire for remote indication, the steam flow integrator, an oxygen record with 2 alarm switches, a steam pressure pen, and a flue gas temperature pen. It also makes an excellent egg timer.

Sound interesting ? Wait'll you see it!

Phil Shagrue Jr.
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

For more information circle **8** on inquiry card.

BREEZE BELLOWS WIN

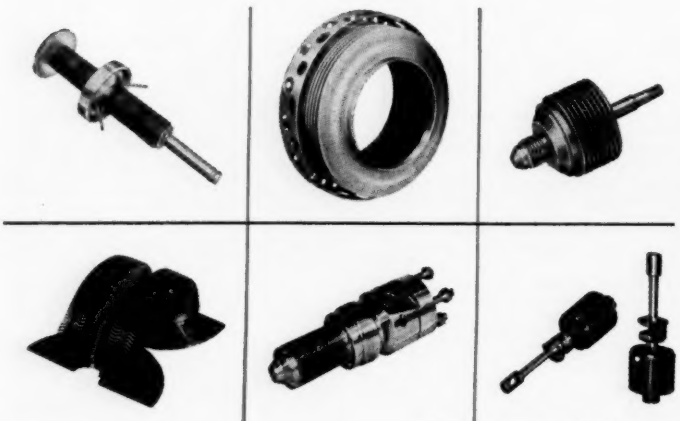
the tough game of high performance

Breeze bellows engineers work in that challenging area where ready-made designs won't do the job. Every project is a custom project, engineered specifically for each problem application.

We have a wealth of experience with all weldable alloys such as Inconel X, titanium, Ni-Span, Hastelloys, Stainless 300 and 400 steels.

We are solving critical problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, expansion and vibration joints, oscillating and rotating shaft seals, atomic and nuclear reactors.

Breeze invites your inquiries on bellows jobs *beyond the routine* . . . for the most exacting requirements.



BREEZE

CORPORATIONS, INC.

700 Liberty Avenue, Union, N. J.

BREEZE MARK

For more information circle 9 on inquiry card.

everything* is CONTROL

with Farris...

Pressure • Chemical and Abrasive Flow • Speed

Farris products have been leaders in the field of instrumentation and control for more than a decade. In fluid control Farris' Safety-Relief Valves, Flex-Valves and X-V Series diaphragm-disc valves offer a three-way choice for meeting your needs . . . If speed control is your problem, Farris-Pickering's line of hydraulic and mechanical governors includes a model for every purpose.

And keep in mind—Farris products of every type are built for quality . . . designed for performance . . . priced for YOU!

* THERE ARE THOUSANDS OF SPECIFIC USES FOR FARRIS PRODUCTS IN

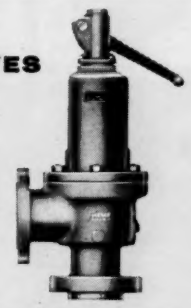
Chemical Processing
Petroleum Processing
Pulp and Paper Manufacture
Mining & Quarrying
Food Processing
Public Works
Smelting & Refining
Metal Working
. . . every major industry!

SEE FARRIS PRODUCTS ON DISPLAY—BOOTH 709
at the I. S. A. Show
Cleveland Aud.: Sept. 9-13

FLUID CONTROL

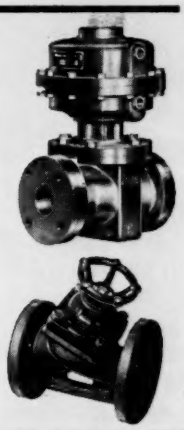
SAFETY-RELIEF VALVES

The world's outstanding line for process and general applications . . . including famous BalanSeal Bellows types (licensed to other manufacturers) that isolate working parts from fluid to give 100% protection 100% of the time, even under variable backpressure conditions. Available with the Farris "Remoter" Depressurizing Safety Valve Control.



FLEX VALVES

The valves of 101 tough uses for every field of control . . . hose-bodied manual and automatic types in standard or new SuperSeal metal-enclosed designs. Also, Farris' X-V Series of low-cost diaphragm-disc valves. All for corrosion, abrasion, slurry and general applications.



SPEED CONTROL

FARRIS-PICKERING GOVERNORS

The Type 3300 Hydraulic is the newest design in this 100-year-old line of speed control devices . . . backed by more than a century of know-how. Modern designs, prompt, efficient repair service and the popular Farris Exchange Plan save you time and money.

PROGRESS THROUGH Farris HONEST PURPOSE

AFFILIATED COMPANIES
400 COMMERCIAL AVE., PALISADES PARK, N. J.

IN TEXAS:
5405 CLINTON DR.
HOUSTON, 20

FARRIS ENGINEERING CORP. • FARRIS FLEXIBLE VALVE CORP. • FARRIS-PICKERING GOVERNOR CO., INC. • FARRIS HYDROSEAL CORP. • FARRIS HYDROTORQUE CORP.

For more information circle **10** on inquiry card.

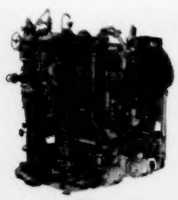
● Manufacturing ●● Manufacturing and product development ●●● Manufacturing, product development and research □●● Pilot manufacturing, product development and research

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	GPE CAPACITIES
●●	□●●	●●●	●●	●●	●●●	●●●	●●●		●●	●●●	Precision Mechanics, Optical Devices, Ceramics
●●		●●●		●●●	●●●	●●●	●●●		●	●●	Electrical Equipment and Components
●●●	●●●	●●●		●	●●●	●●●	●●●		●●	●●	Electronics
●●●			●●●					●●●	●●		Hydraulics, Liquids Processing, Heat Exchange
	●●●	●●●		●●	●				●●●	●●●	Motion Picture, Photographic, Television and Audio Equipment
●●●	□●●	●●●		●●	●●●	●●●	●●●	●●●	●	●●	Instruments, Servos, Controls: Hydraulic, Pneumatic, Magnetic, Electronic
●●	●●●	●●●		●	●●●	●●●	●●●		●		Aircraft and Missile Guidance, Control, Simulation
●●●	□●●				●●●	●●●	●●●		●		Automatic Computers and Components
●	●●●				●●●	□●●	●●		●	●	Radar, Microwave, Ultrasonics
●●			●●		●●●	●●●					Nuclear Power Components and Controls
●●●	●●●		●●●		●●●	●●●	●●●	●●●			SYSTEMS ENGINEERING

Librascope Desk-Size Computer

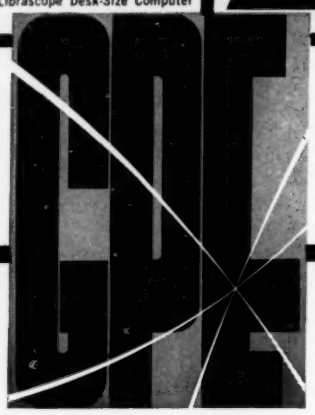
Link Aviation F-89D Jet Simulator

GPL Industrial-Institutional TV System



Griscom-Russell Shipboard Distilling Plant

Askania Electro-Jet Power Package



SYSTEMS ENGINEERING

The GPE Companies are leaders in that small, select group in American industry which is broadly qualified to develop and produce the systems needed today for defense and industry. GPE leadership accounts for some of the most advanced systems in use in business, television, aviation, marine, steel, oil, and other industrial fields.

In Systems Engineering, highly advanced capacities and resources are prerequisite. Yet, no matter how highly advanced, they are of little use if limited to a few areas. Finding optimum solutions to complex systems problems calls for *balanced competences*. And beyond that, success calls for the consistent application of such competences *at every stage* — beginning with research, and extending all the way through development, production and final testing.

No GPE company is limited by the boundaries of its own specialties. The basic GPE operating policy, GPE Coordinated Precision Technology, places at the command of each company in the group all GPE research, development and production facilities, and the skills and experience of the approximately 4000 GPE technical men working in depth in the wide range of advanced capacities indicated in the chart above.

Behind each group working on a specific problem in one GPE company stands the whole group of GPE scientists, engineers and technicians with the answers — or the knowledge that will find the answers — to questions underlying and related to that problem. To the customers of GPE Companies this means that the concept and development of equipment, components and systems are not restricted or distorted by traditional allegiance to specific competences.

The five systems illustrated, while products of different GPE companies, are all examples of the consistent application of balanced competences, achieved through GPE coordination. For brochure describing GPE Coordinated Precision Technology and the work of the GPE Companies, or help on a specific problem, write: General Precision Equipment Corporation, 92 Gold Street, New York 38, N. Y.

GENERAL PRECISION EQUIPMENT CORPORATION

THE GPE PRODUCING COMPANIES

I ASKANIA REGULATOR COMPANY · II GENERAL PRECISION LABORATORY INCORPORATED · III GRAFLEX, INC.
IV THE GRISCOM-RUSSELL COMPANY · V THE HERTNER ELECTRIC COMPANY · VI KEARFOTT COMPANY, INC.
VII LIBRASCOPE, INCORPORATED · VIII LINK AVIATION, INC. · IX SHAND AND JURS CO. · X SIMPLEX EQUIPMENT CORPORATION
XI THE STRONG ELECTRIC CORPORATION

For more information circle **11** on inquiry card.

Events

September 3-13

Denver Research Institute course on computer applications, University of Denver, Denver 10, Colorado.

September 4-6

Magnetic Amplifiers Conference of the Institute of Radio Engineers-American and the Institute of Electrical Engineers, Penn Sheraton Hotel, Pittsburgh, Pa. For information write AIEE, 33 W. 39th St., N. Y. 18, N. Y.

September 9-13

12th Annual ISA Conference & Exhibit, Auditorium, Cleveland, Ohio. For information write William Kushnick, 313 Sixth Ave., Pittsburgh 22, Pa.

September 17-18

Symposium on Numerical Control Systems for Machine Tools sponsored by the Radio-Electronics-Television Manufacturers Assn., Ambassador Hotel, Los Angeles, Calif. For information write Engineering Dept., RETMA, 11 W. 42 St., New York 36, N. Y.

September 23-25

Twelfth Annual Conference of the Petroleum Div. of The American Society of Mechanical Engineers, Hotel Mayo, Tulsa, Okla. For information write: ASME, 29 W. 39 St., New York 18, N. Y.

September 23-25

6th Annual Meeting of the Standards Engineers Society, Hotel Commodore, New York, N. Y. For information write Standards Engineers Society, Box 281, Camden 1, N. J.

September 24-25

Industrial Electronics Conference, sponsored by the Institute of Radio Engineers and American Institute of Electrical Engineers, Morrison Hotel, Chicago, Ill. For information write A.I.E.E., 33 W. 39th St., New York 18, N. Y.

October 7-9

National Electronics Conference, Hotel Sherman, Chicago. For information write National Electronics Conference, 84 E. Randolph St., Chicago 1, Ill.

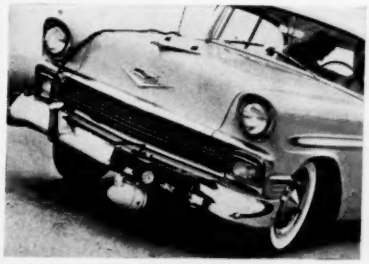
October 10

Reliability and Quality Control in Electronics conference of the A.I.E.E., Silver Springs, Md. For information write A.I.E.E., 33 W. 39th St., New York 18, N. Y.

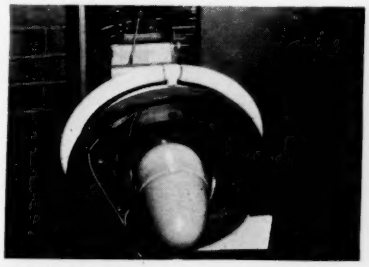
CLOSED-CIRCUIT TV *in action*

See how industry is solving tough problems *visually*—with GPL *ii-TV

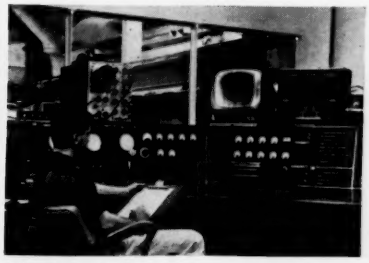
Quick record reference via *ii-TV* permits concentration of records in one area, saves this user $30,000 a year. GPL system is simple enough for anyone to operate.



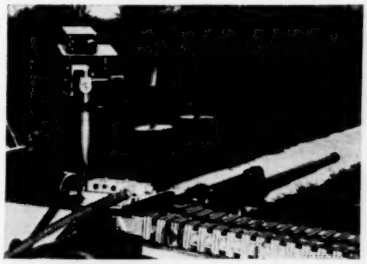
Hard-to-see actions, as in the bouncing under-chassis of GM cars in road test, *above*, can now be viewed. Standard GPL TV camera takes hard knocks in stride.



Monitoring distant meter saves this manufacturer substantial sums in electric bills by avoiding peak loads. Reliable, remotely located TV camera by GPL needs no tending.



Observer is safe when dangerous operations, like this one involving radiation at Brookhaven National Laboratory, are seen through sharp pictures of GPL camera.



Even bone-shattering concussions can't disturb perfect pictures of GPL's Ruggedized camera, designed specifically for most severe applications.

Basic *ii-TV* system is finest, most dependable; costs less than medium-priced car. Mobile GPL TV Projector gives wall-size pictures 300% brighter than any other.

SEE *ii-TV FOR YOURSELF**

For further details, or demonstration of this precision-engineered system in your own office or plant by local GPL representative, write on your letterhead to Mr. N. M. Marshall, Sales Manager, General Precision Laboratory Incorporated, 61 Bedford Road, Pleasantville, N. Y.

*GPL's *industrial-institutional TV* system.

ISA Show Booth 1446

GPL — SUBSIDIARY OF GPE

General Precision Laboratory Incorporated

For more information circle **12** on inquiry card.

Kearfott Components

FOR EVERY SYSTEM APPLICATION

KEARFOTT offers the systems manufacturer the most complete line of precision made components available anywhere. Quantity production enables quick deliveries and reasonable prices.

SYNCHROS—Transmitters, Control Transformers, Resolvers, Repeaters, and Differentials in Bu Ord Sizes 8, 11 and 15. High Accuracy and environmental resistance.

SERVO MOTORS—High torque, low inertia Servo Motors, Inertial and Viscous damped Servo Motors, in Bu Ord Sizes 8, 11, 15, 18 and 23.

TACHOMETER GENERATORS—Available as damping generators, rate generators and integrators. They feature high output to null ratio and extremely linear outputs. Temperature stabilization may be provided.

GYROS—Directional, floated rate integrating, free, vertical, and spring restrained rate gyros for all airborne navigation, stabilization or fire control applications.

Bulletins giving physical and technical data of the various Kearfott Products will be sent on request. The Kearfott organization is available to assist in the development and manufacture of other precision components you may require.

Kearfott

A SUBSIDIARY OF GPE
GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill. South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle **13** on inquiry card.

October 17-18

National Conference on Industrial Hydraulics, Sherman Hotel, Chicago, Ill. For information write Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

October 24-25

Computer Applications Symposium, Sherman Hotel, Chicago, Ill. For information write Armour Research Foundation, Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

November 2-10

INTERKAMA (International Congress and Exhibition of Measuring Instrumentation and Automation), Dusseldorf, Germany. For information write Nordwestdeutsche Ausstellungs-Gesellschaft m. b. H., Ehrenhof 4, Dusseldorf, West Germany.

November 6-8

I.R.E. 1957 Aero-Com Symposium, Hotel Utica, Utica, N. Y. For information write R.A. Zachary, Vice Chairman for Technical Program, 11 Arbor Drive, New Hartford, N. Y.

November 7-8

Louisiana Polytechnic Institute 6th Annual Instrumentation Conference, Louisiana Polytechnic Institute, Ruston, La.

November 11-13

Instrumentation Conference and Exhibit, Institute of Radio Engineers, Biltmore Hotel, Atlanta, Ga. For information write B. J. Dacher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

December 8-11

Eastern Joint Computer Conference, sponsored by IRE, AIEE and Assn. for Computing Machinery, Shoreham Hotel, Washington, D. C. For information write Morton M. Astrahan, IBM Corp., San Jose, Calif.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.M., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 9-13, 1958

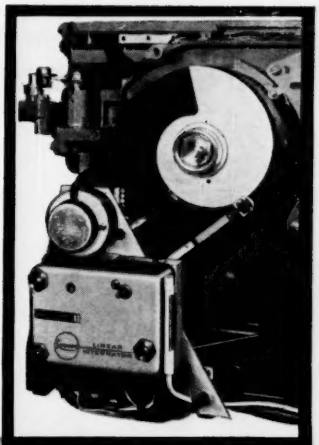
Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

See us Booth No. 1446
I.S.A. Show—Cleveland
Sept. 9-13

THE LIBRASCOPE

Model 25 COMPUTING LINEAR INTEGRATOR

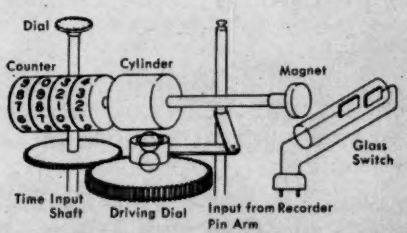
for flow totalization • temperature recording averaging • area computations in gas analysis procedures



Model 25 Librascope Computing Linear Integrator mounted on a Strip Chart Recorder. In this position it accepts the output of the transducer or the recorder pen motion as an input.

Eliminates manual integration of recording data.
Provides continuous integration.
Direct reading and also remote reading through electrical impulse output.
Fits all Standard or Miniature Strip Chart Recorders.

Typical Adapter Kit of Model 25 Librascope Computing Linear Integrator with parts. These include baseplate, case, disc, roller, linkages, input shaft, bearings and carriage guides.



Model 25 Computing Linear Integrator is a *ball disc integrating mechanism* assembled with a counter and an electrical pulse output switch for remote recording.

The Model 25 *Librascope Computing Linear Integrator* is designed to provide a fast, accurate, reliable, continuously integrated total of data as it is being recorded or presented. (The Model 25 Computing Linear Integrator ends inaccuracies of totalizing by eliminating manual integration.) The Model 25 can be installed on any device having shaft rotation or displacements as an output.

SPECIFICATIONS

Accuracy—1% full scale
Shaft Rotation—0°—100°
Range—0%—100%
Input Shaft Torque—0.1 in. oz.
Outputs—
Mechanical counter—4 digits
Electrical Pulse
DC Volts: 28—amps.: 0.5
AC Volts: 110—amps.: 0.5
Size—3.0"x4.38"
Weight—1.5 (lbs.)
Computer is sealed against dust.

Computors, Controls, Components

Representatives located in principal cities

LIBRASCOPE
A SUBSIDIARY OF CPE

Librascope, Incorporated • 808 Western Ave. • Glendale, California

Installation kits are designed to fit any standard or miniature chart recorders. For detailed information of Model 25, write for Computing Linear Integrator Bulletin just released.

For more information circle **14** on inquiry card.

CONSOTROL* RECORDING

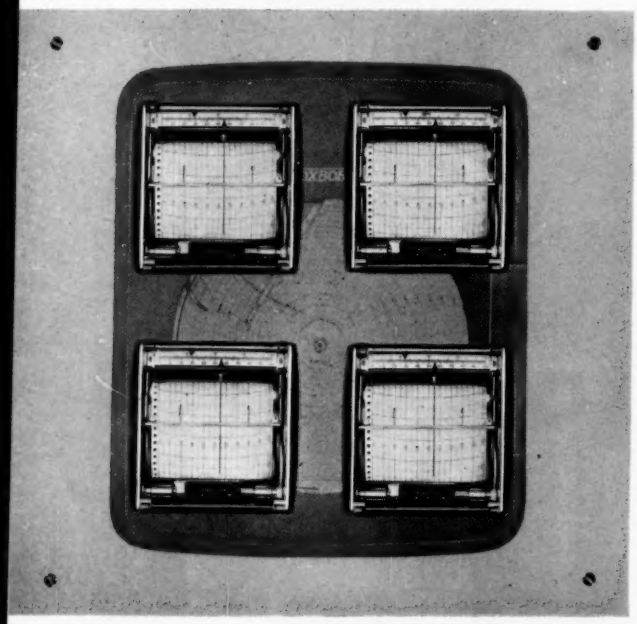


Illustration shows how 4 Consotrol Instruments require less panel space than does a single, conventional 12" recorder.

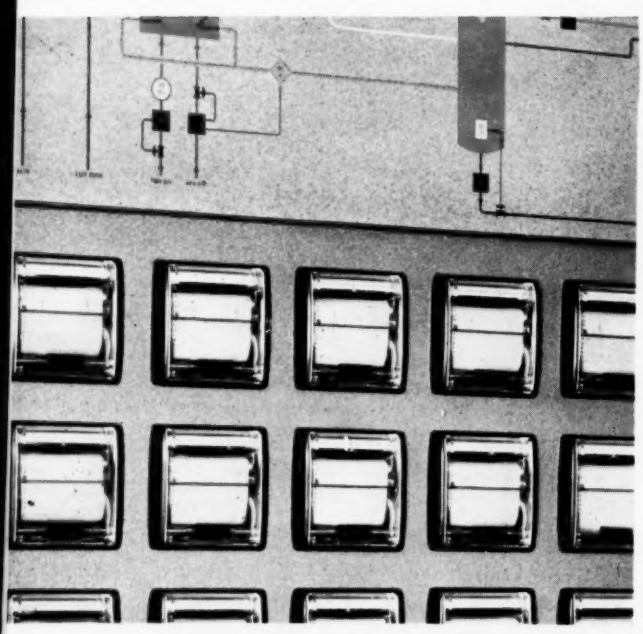
The ORIGINAL small-case control panel instrument with a FULL SCALE 4 INCH CHART...

Full-scale *readability!* Here is the industry standard set by Consotrol Instruments, with no compromise in compactness, convenience, or performance.

These Recorders and Recording Control Stations are so compact you can actually mount 4 in the space required by 1 standard 12-inch recorder. And yet, inside the case, all components are full size — nothing is "miniature."

With the integrally mounted Model 58 Controller, the Foxboro Consotrol Recording Control Station provides precise, dependable control and full-scale chart records in one-quarter the panel space. Maintenance is easier too, with all calibration adjustments made from the front . . . re-inking needed only twice a year . . . chart changes as seldom as once a month.

For the complete story, write for Bulletin 13-18. **The Foxboro Company, Dept. A 468 Norfolk St., Foxboro, Massachusetts, U.S.A.**



Typical control panel showing Consotrol Recording Control Stations. Associated M/58 Controllers, integrally mounted, pull out with the recorders.

INTRODUCED IN 1952 — OVER 25,000 NOW IN USE

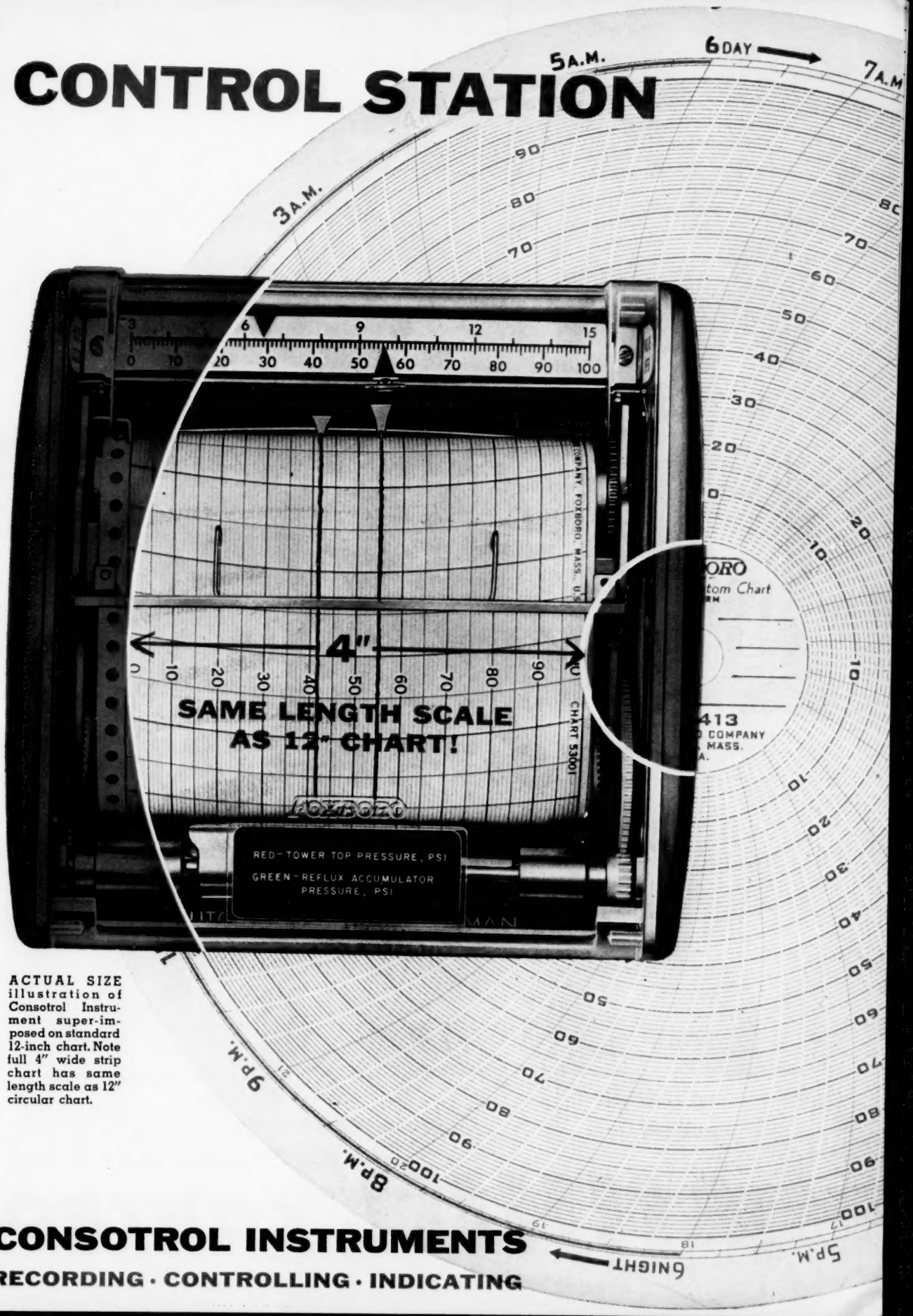
*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

For more information circle **15** on inquiry card.

CONTROL STATION



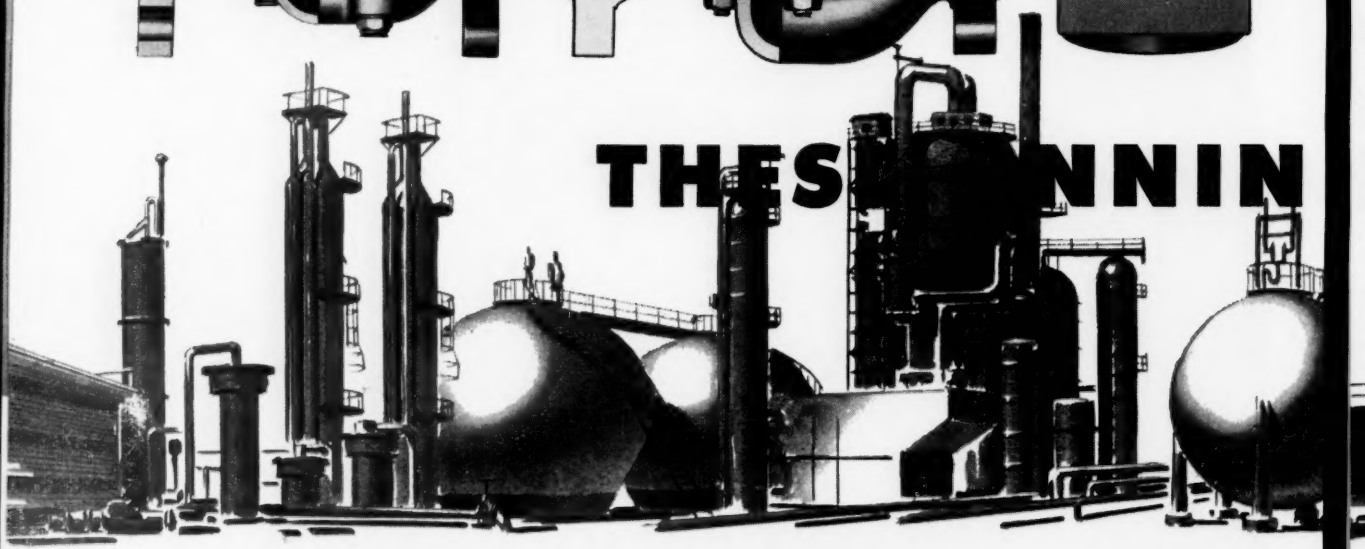
ACTUAL SIZE illustration of Consotrol Instrument super-imposed on standard 12-inch chart. Note full 4" wide strip chart has same length scale as 12" circular chart.

CONSOTROL INSTRUMENTS

RECORDING · CONTROLLING · INDICATING

CONTROL VALVE BODY
600 lb. ASA rating

CONTROL VALVE BODY 900 and 1500 lb. ASA ratings



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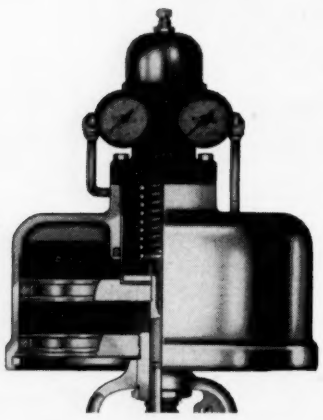
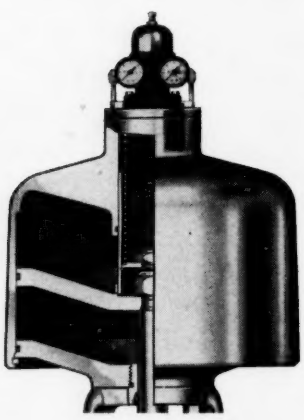
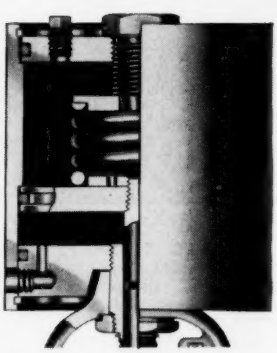


DOMOTOR OPERATORS



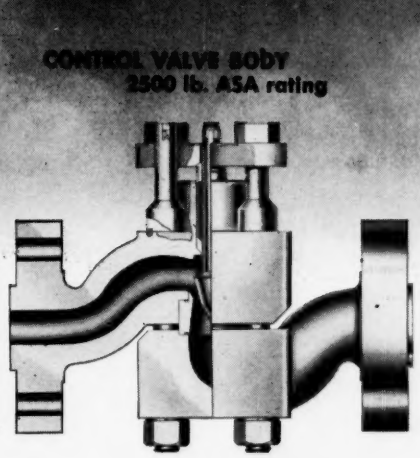
BUNYAN DOMOTOR OPERATORS



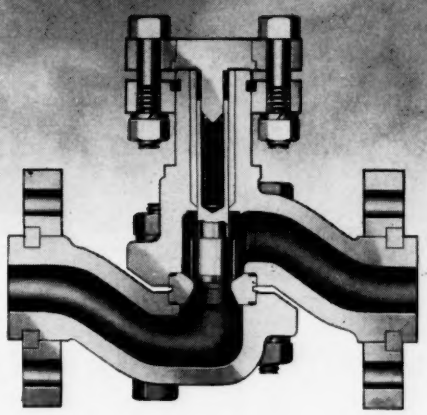
CYLINDER OPERATORS

ANNIN CONTROL

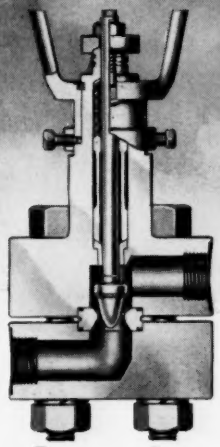
For more information circle **16** on inquiry card.



CONTROL VALVE BODY
2500 lb. ASA rating

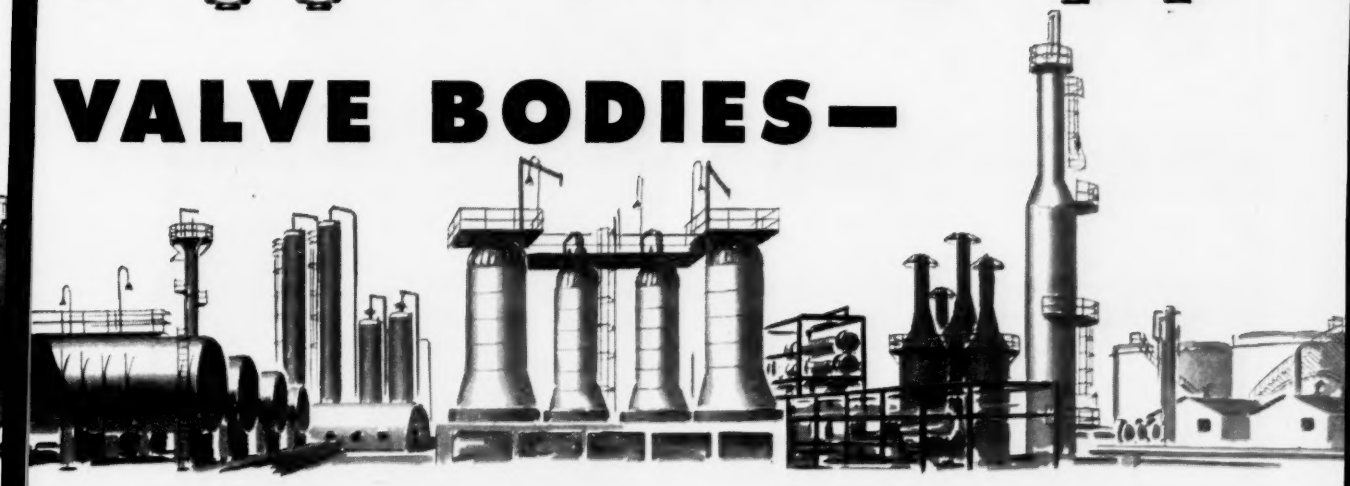


CHECK VALVE BODY
600 to 2500 lb. ASA ratings

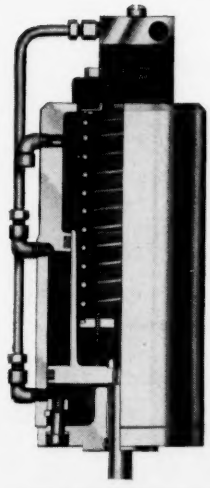


CONTROL VALVE BODY
2500 and 10,000 lb. ratings

VALVE BODIES—



OPERATORS...



STROKE POSITIONING OPERATOR

PNEUMATIC-HYDRAULIC OPERATORS

add up to the most complete line of control valves and other final control elements available anywhere!

THE ANNIN COMPANY

Division of the Annin Corporation
1040 S. Vail Avenue, Montebello, California

VALVES

SEE ANNIN'S BOOTH NOS. 1535 & 1537

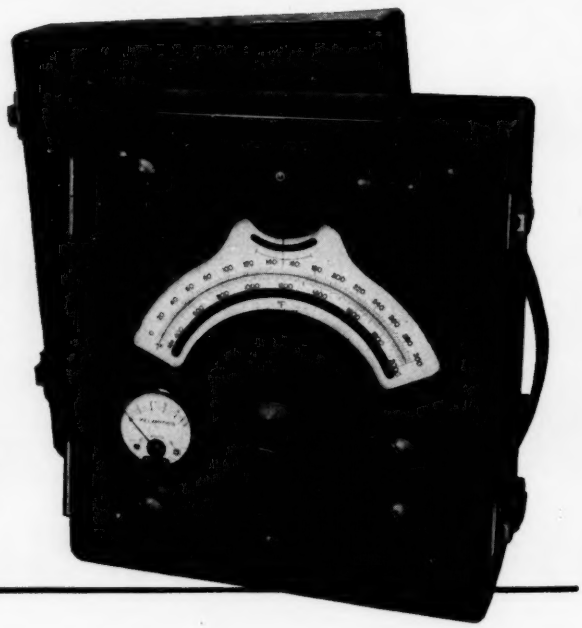
12th Annual ISA Instrument-Automation Conference and Exhibit

September 9-13, Cleveland, Ohio

LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY



ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **17** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Shortage of skilled labor is growing--and becoming serious in many industries; U.S. industry is training only 1 apprentice for every 50 skilled workers--far less than even replacement rate. Secretary of Labor Mitchell estimates that 5 million additional skilled technicians must be added to present 9 million by 1965 if $560 billion gross national product is to be attained. Answer is on-the-job subsidized upgrading training by industry plus more automation. Technical institutes are ready (see I&A, May, 1957, page 887) with facilities to provide the training. High-school systems throughout nation are watching automation experiment in Pittsburgh (see I&A, May, 1957, pages 868-870). Instrument industry is ready with automation equipment.

1956 sales of closed-circuit TV exceeded $3 million; 1957 sales are expected to be $4 to $5 million. Major users are industry, education, military.

Growth of basic industries in decade 1945-55: aluminum--425%; chemical--260%; electric utility--232%; natural gas--231%; crude oil--164%; paper--160%; steel--142%; coal--93%. Instrument industry increased 420% in that decade, making possible, in part, these basic industry growths.

More than 30 different digital computers are now offered in 10 Western European countries. More than 6 manufacturers plan mass production. U.S. computer manufacturers are establishing branch factories in Europe. First UNIVAC system in Frankfurt is heralded as start of office automation in Europe.

Nation's basic research effort in the natural sciences--physical and life sciences combined—was $435 million in 1953, reports the National Science Foundation. This is only 8% of the total $5.4 billion R&D expenditures for 1953; only 0.1% of gross national product of $363 billion.

Universities are principal performers of basic research, accounting for $205 million of the $435 million total reported for 1953; industry $170 million; government $48 million; others $14 million. Of $435 million total basic research effort in 1953, $309 million was in the physical sciences, only $126 million in life sciences—biological, medical, agricultural.

More than 100 nuclear power reactors are expected to be built in Europe within a decade. U.S.A. is losing this market to others because of our policy of restrictive bilateral agreements, dependency on enriched fuels (obtainable only from U.S.A.), and attitude of "we give, you take, and on our terms." British-type reactor has been recommended for Japanese use by team of Japanese.

INSTRUMENTS and AUTOMATION News

Principles & Applications 1417 to 1424
New Plants & Mergers 1434
People in the News 1436

Computers Study Languages

PASADENA, CALIF.—Recently the National Bureau of Standards completed a brief exploratory syntax study of 550 sampled English sentences with the help of its automatic digital computer, the SEAC. The results were inconclusive but sufficiently interesting to justify further investigation along the same lines. Almost simultaneously an electronic computer was being programmed to interpret four foreign languages and automatically type out idiomatic English translations. ElectroData Div. of Burroughs Corp. revealed that Peter Toma at Cal Tech had fed excerpts in four languages—Russian, French, German and Spanish—into a Datatron which printed the precise English equivalents on an electric typewriter.

Idiot II is no Idiot

NEW YORK, N. Y.—An electronic brain, Idiot II (Instrumentation Digital On-Line Transcriber), capable of handling 128 separate pieces of information at one time, absorbs information as electric signals, and converts it into numbers recorded on magnetic tape at speeds of 10,000 per second and up. Recordings or readings are translated into the language necessary for further processing in an electronic computer, through an electronic playback. The system, designed by Dr. Martin L. Klein, head of Rocketdyne Advanced Instrumentation Development Unit, North American Aviation, represents a significant advance in high-speed data handling through the "packaging" of an electronic recorder, playback, and computer. Minneapolis-Honeywell Regulator Co. has been licensed to manufacture and sell the equipment which is currently used by Rocketdyne to record data during test runs of engines being built for guided and ballistics missiles.

Electronic Traffic Cops

MELROSE PARK, ILL.—A successful electronic traffic cop, El-TEC, designed by Electronic Protection Inc., has received unqualified backing from the traffic engineer and director of traffic in Baltimore. The system sets up radio-electronic control of traffic lights and is operated by the driver of emergency vehicles (fire equipment, police cars, ambulances, civil defense, etc.) several blocks in advance. It is designed to solve serious traffic accidents and delays in emergency situations and is in use in Ogden, Utah; Jackson, Mich; New Haven, Conn; Havana, Cuba; suburban communities of Chicago, Ill; and other cities.

Education News

► In September, sixty of Pittsburgh's leading math-science-major high-school seniors will begin the nation's first formal high-school course in instrumentation-automation, an experiment that will be watched throughout the nation. Appeal for funds has been made to foundations and other sources interested in instrument education. Donations will be reported here next month.

► A closed-circuit TV project bringing varied educational training into the TV sets of 608 families living in four apartment houses of a public housing area in Manhattan's Chelsea district is linked with Public School 33, the Hudson Guild Neighborhood House and the Lower West Side Health Center. Financed by a $200,000 grant from the Fund for the Advancement of Education, and sponsored by the New York City Board of Education and the Hudson Guild, and Language Research Inc., the TV installation is engineered and equipped by General Precision Lab.

► In cooperation with a number of leading universities, the Western Electric Co. has launched a program of graduate education for its engineers. About 2000 students per year will engage for periods in full-time off-the-job study. The program is equivalent in cost and administrative effort to the establishment of a new engineering school of 1000 full-time students.

► The National Science Foundation announces September 3, 1957 as closing date for applications for a second group of Science Faculty fellowship awards to be given this year. These fellowships offer studies in mathematical, physical, medical, biological, engineering, and other sciences.

► The American Association of Physics Teachers calls attention to the potential market existing in physics teaching equipment. The Committee of Apparatus is obtaining information on the apparatus needs by questionnaires and personal visits to colleges and universities, and will report definite needs to the industry.

New Research Foundation

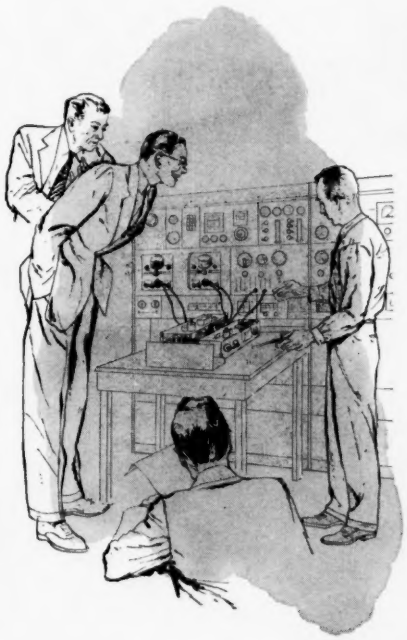
COLUMBUS, OHIO—Denison Research Foundation. a not-for-profit Ohio corporation was recently formed with initial emphasis on projects in electronic, mechanical, metallurgical, ceramic and management fields. Its founder is Mr. W. C. Denison, president of The Denison Engineering Co. of Columbus, Ohio, who will be chairman of a Supervising Board of Consultants. Seat of the Foundation is Powell, Ohio, and Mr. Jack P. Pedersen has been appointed its Director.

transistor power supplies

NEWLY DESIGNED FOR TRANSISTOR VOLTAGES

• 3 RANGES—FINE RESOLUTION • TUBELESS
• LOW COST • CONTINUOUSLY VARIABLE

These new T-Nobatrons are the perfect solution to the problem of providing well-regulated voltages for the development and testing of transistor circuits. They provide stable DC output voltages in three ranges, with fine resolution. Excellent transient response for line and load pulses. Simple tubeless construction means greater reliability, lower cost, Also ideal for many other applications in these voltage ranges, such as relay testing and computer circuitry development.



• DUAL RACK INSTALLATION

ELECTRICAL CHARACTERISTICS

Model	T50-1.5	T60-5	T120-2.5
AC Input (60 ~ , 1φ)	95-130	95-130	95-130
DC Output Voltage	0-10	0-10	0-25
(three ranges)	0-25	0-25	0-50
	0-50	0-60	0-120
Output Current (amps.)	0-1.5	0-5	0-2.5
Regulation, line: 105-125 V	±1%	±0.5%	±0.5%
For wider input	±2%	±1.0%	±1%
Internal Resistance, typical (ohms)			
low-voltage range	1.2	0.35	1.3
middle range	2.1	0.55	2.0
high range	4.5	1.0	4.0
Ripple (mv)	50 max.	50 max.	50 max.
Time Constant (line)	0.08 sec.	0.08 sec.	0.08 sec.
(load)	0.15 sec.	0.15 sec.	0.15 sec.

MODEL T50-1.5

See us at
WESCON
Booths
1520-1521

SORENSEN & COMPANY, INC. Sorensen® **SO. NORWALK • CONN.**

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **18** on inquiry card.

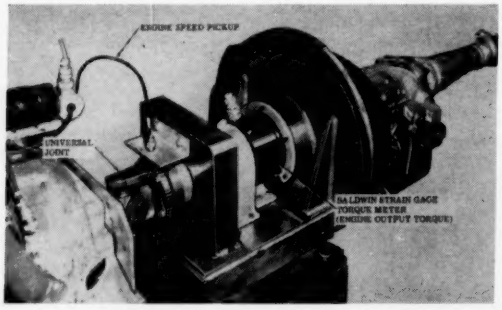
Ammonia Yield Boosted by Gas Analyzer/Controllers

PHILADELPHIA, PA.—Thermal conductivity analyzers and electronic recorders, installed by Leeds & Northrup at Atlantic Refining's synthetic ammonia plant, make it possible to maintain a precise hydrogen/nitrogen ratio

essential to process economy. A Wheatstone-bridge circuit measures the resistance of a heated wire surrounded by the sample gas. Any change in the composition of the gas results in unbalance in the bridge. The Speedomax circuit detects this condition and resotres the balance, recording and indicating the new gas concentration.

Inertia-Wheel Testing

PHILADELPHIA, PA.—Through the use of electric strain-gage torquemeters, engineers at Ford's Dearborn Research and Engineering Center have been enabled to take engine and transmission testing off the road and into the laboratory. The new in-doors method (called inertia-wheel testing) is cheaper, faster and more accu-

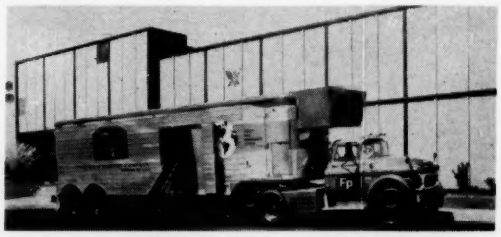


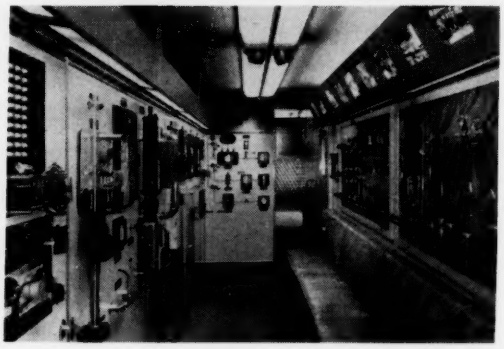
rate. It uses Baldwin SR-4 torquemeter sensing and measuring instruments, and permits engine and transmission loads, under rapidly changing conditions, to be measured in the lab.

News Bits

K. E. HALLIKAINEN, newly elected president of the Northern California Section ISA reports that the *First Annual Instrument Symposium* held in mid-May was a great success; 195 conferees registered, an additional 60 people attended the Maintenance Clinics, and a record attendance of 665 people crowded the concurrent Exhibit, which was held for the sixth time. Highlight of the conference was Dr. William Shockley's talk on "The Future of Semiconductors."

FISCHER & PORTER CO. is sending a mobile exhibit of its products on a swing around the country.—The company also announces that it has acquired all

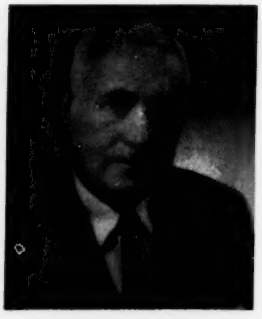




sales and manufacturing rights to equipment developed by Olin Mathieson Chemical Corp. for generation of chlorine dioxide from sodium chlorite.

SAMA announces the appointment of George E. Lawrence to manage its Washington office.

FISHER GOVERNOR CO. hosted thirty-two representatives of the chemical and petroleum industries of Houston and Corpus Christi, Tex., during a two day visit.



FRED A. LENNON, president of Crawford Fitting Co. has accepted the General Chairmanship, Host Committee, 12th Annual ISA Instrument Conference & Exhibit, Cleveland, Ohio, Sept. 9-13. The familiar Swagelok shuttle busses, known from prior Exhibits, will be moving this time on familiar ground.

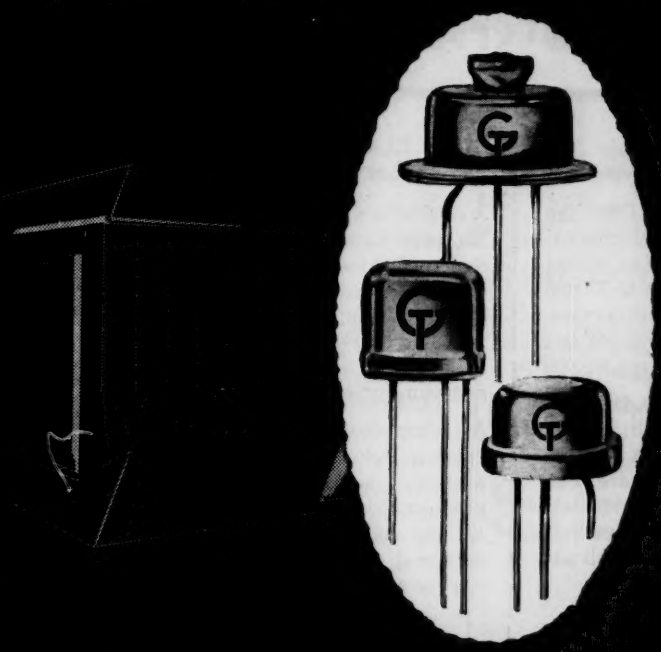
MINNEAPOLIS-HONEYWELL REGULATOR CO. has received a $400,000 order for automatic industrial control instruments and valves from Petreleo Brasileiro, Salvador, Bahia. Deliveries started on July 2.

The American Society of Mechanical Engineers, Sectional Committee C85, has started a project to establish standard terms pertaining to automatic control, and to develop definitions of such terms. Secretary of the committee is G. W. Heumann, General Electric Co., Schenectady, N. Y.

UNION SWITCH & SIGNAL has installed fully automatic equipment named "Velac" at Union Railroad's Mon Southern Yard, which provides routing of a cut of cars to any of the 23 classification tracks.

VERSATILITY OF DESIGN

TRANSISTORS



G.T. computer transistors

- MINIATURIZATION
- PORTABILITY
- RELIABILITY
- EXTENDED LIFE

Simplifying and miniaturizing circuitry with GT germanium alloy type transistors, control engineers are now able to design lighter weight, portable, more reliable units than by previous methods with conventional components.

General Transistor's PNP and NPN transistors are playing a vital role in advancing the designs of control systems.
Versatility of design is now available write today for Bulletin G-100 containing all types list and dimensional drawings.

Typical Applications:
- Relay Amplifier
- Direct Current Switch
- Photoelectric readout & control
- Micro and millisecond switching
- Servo driver applications
- Control lighting
- Phase detector circuitry
- Low level modulation

GENERAL TRANSISTOR CORPORATION

For more information circle **19** on inquiry card.

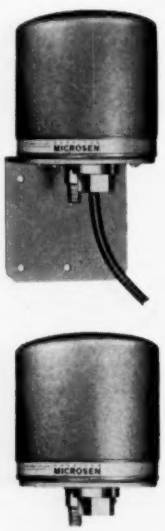
LOOK WHAT

'American-Microsen' Electronic

ELECTRONIC TRANSMITTERS

"Complete" is the word for the line of 'American-Microsen' Transmitters. You can select units for pressures up to 50,000 psi and all temperature ranges, as well as for flow, level, pH and all the electrical measurements.

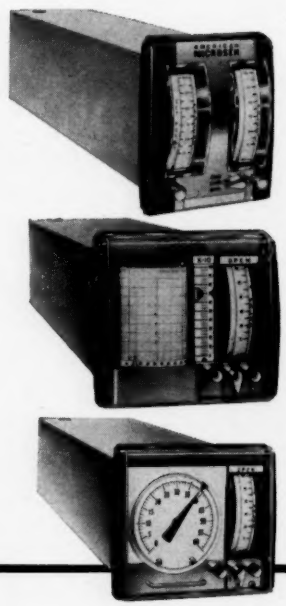
These instruments can transmit up to 30 miles in a split second, and the dc signal is most accurate and trouble free. They are compatible with practically all data logging and computer systems and extremely easy to install and maintain.



ELECTRONIC CONTROLLERS

. . . and here's the new 'American-Microsen' Controller. You have a choice of three plug-in units – a vertical scale indicating controller, a recording controller, and a round-scale indicating controller that can be interchanged with the recording type in seconds.

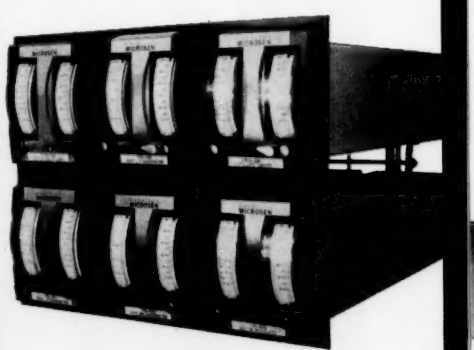
All components are in a single housing. Equally important, the controller is transistorized for greatest reliability and long service life. All control modes – proportional, rate, reset, cascade, etc. –are available.



MULTI-UNIT GROUPINGS

Now, here's a new idea that helps cut the cost of your panels and even your control rooms. You can "cluster" a whole group of controllers and recorders in a single unit. The group mounts on a standard relay rack and occupies an absolute minimum of panel space.

There's no clutter of wires and pipes behind the panel – with the 'American-Microsen' System! Even with the controllers mounted so close, the installation is clean and easy to service.



MANNING,

MAXWELL MANNING M&M E MOORE INC. TRADE MARK

'AMERICAN-MICROSEN' . . . the all-electronic system of miniature-type instruments that provides the ultimate in process control, product quality and total economy.

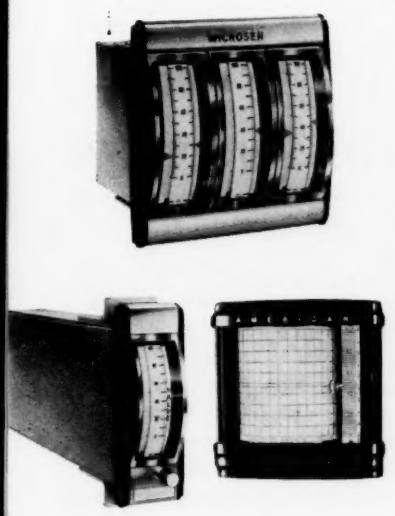
For more information circle **100** on inquiry card.

YOU GET in the
Transmission and Control System

VERSATILE . . . INTERCHANGEABLE

Take a look at this vertical scale indicator. It can have one or two separate pointers on a single scale and comes in multi-unit enclosures to take up the least possible space on the panel.

Talk about a neat package – this slim manual valve operating station is it! It uses the same components as the controllers. You can be sure the 'American-Microsen' Electronic Transmission and Control System offers a whale of a lot in interchangeability.

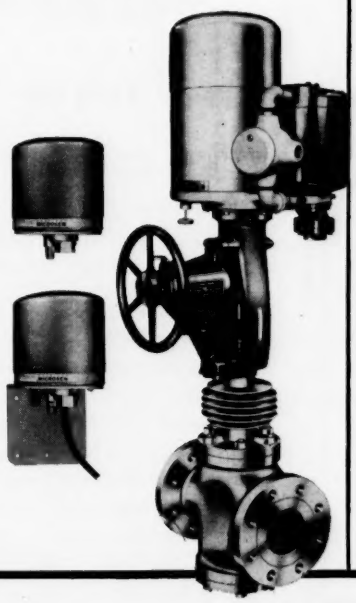


TRANSDUCERS . . . VALVE OPERATORS

You can operate pneumatic diaphragm valves with these transducers – or you can use the self-contained electro-hydraulic valve operator and eliminate all air.

The electro-pneumatic relay has a built-in booster to give a capacity of 8 cfm. That's the highest of any!

The 'American-Microsen' electro-hydraulic valve operator will stroke all valves up to 16 inch and larger. It delivers up to 3250 lbs. of thrust. *No other in its price range compares with that!*



SEE

OUR EXHIBIT AT THE

I.S.A. SHOW

Convince yourself! See the 'American-Microsen' Instruments at the ISA Instrument-Automation Conference and Exhibit. Visit Booths 932-936-938-940 at the Cleveland Auditorium, Cleveland, Ohio – September 9th through 13th.

If you can't make the ISA Show, write for literature and ask a sales engineer from our nearby district office to call and explain the advantages of 'American-Microsen' Instruments for measurement, transmission and control. You will not be obligated in any way.

MAXWELL & MOORE, INC.

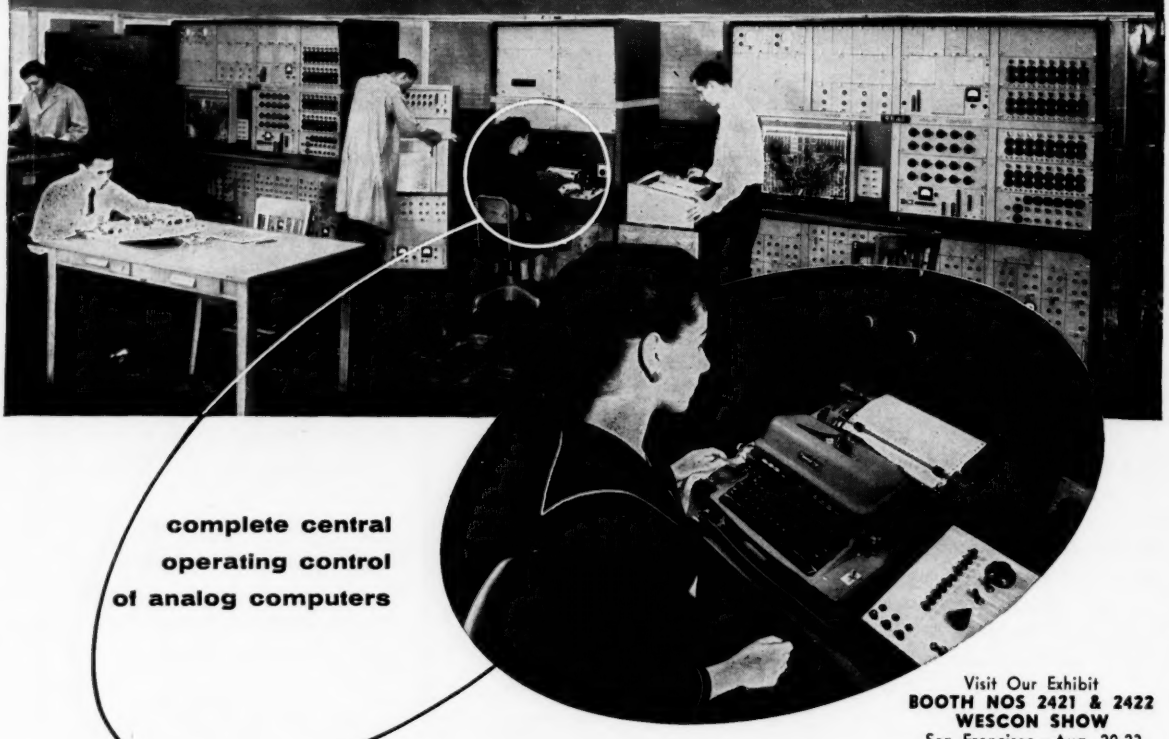
INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **100** on inquiry card.

a major break-through in computer efficiency



complete central
operating control
of analog computers

Visit Our Exhibit
BOOTH NOS 2421 & 2422
WESCON SHOW
San Francisco—Aug. 20-23

with the new REAC®

AUTO-CONTROL SYSTEM

Here in brief are the capabilities of this new auto-control system.

From typed command or punched tape

Set any scale factor or problem check pot under load. • Read out setting of any scale factor or problem check pot under load. • Read actual voltage of any pot under load. • Measure voltage at any amplifier or selected point in computer. • Put computer into any operating mode.

Auto-cycle automatically reads out

All amplifiers. • All integrators. • All scale factor pots onto tape or hard copy. • All problem check pots onto tape or hard copy. • All amplifiers *and* all pots, as above. • Auto-set all pots to zero . . . and, in addition, the system permits automatic programming of computer operation.

Increases time computer is available for actual running of problems.

Not a press agent's dream, nor an artist's conception, but an actual working system, this new REAC Auto-Control System is showing the way to new levels of analog computer efficiency. Used in conjunction with the REAC Problem Check, Time Scale Check and Voltage Scale Check Systems, it allows a problem to be inserted and checked out in a fraction of the normal time. Problems can be taken off and reinserted fast enough so that trouble-shooting of computer problems, re-scaling of time and voltage parameters, and preliminary evaluation of results can be done while the machine is busy on another problem. Multi-shift operation becomes really practical, too.

The REAC Auto-Control System adds a completely new dimension to the analog computer technique. Write for complete details on what it can mean to you.

REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America, 225 East 91st St., New York 28, New York

Reeves INSTRUMENT CORPORATION

6RV57

REAC Analog Computers

Precision Floated Gyros

Precision Resolvers and Phase Shifters

Servo Mechanical Parts

For more information circle **20** on inquiry card.

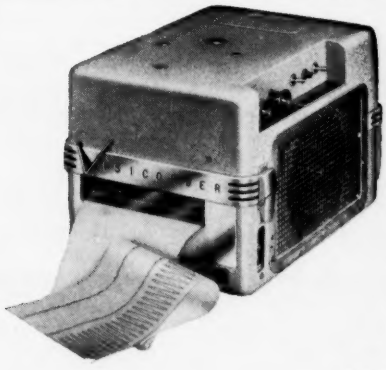
all at once...

the HONEYWELL VISICORDER®

directly records six phenomena at frequencies from DC to 2,000 cps

The versatile Visicorder will fit almost unlimited oscillograph applications where instantaneous monitoring and direct recording at high frequencies are needed.

The Visicorder is the only oscillograph that records directly at frequencies up to 2,000 cps, and at sensitivities comparable to photographic-type oscillographs. No peaked amplifiers or other compensation of any kind are needed. The record requires no liquids, vapors, powder magazines or other processing materials.



Deflection is six inches peak to peak, covering the full width of the chart. The D'Arsonval-movement mirror galvanometers, in your choice of natural frequencies will, of course, overlap their traces; they are not limited by adjacent channels.

Let your nearest Honeywell Industrial Sales Engineer tell you more about how the Visicorder fits *your* application. Call him today.

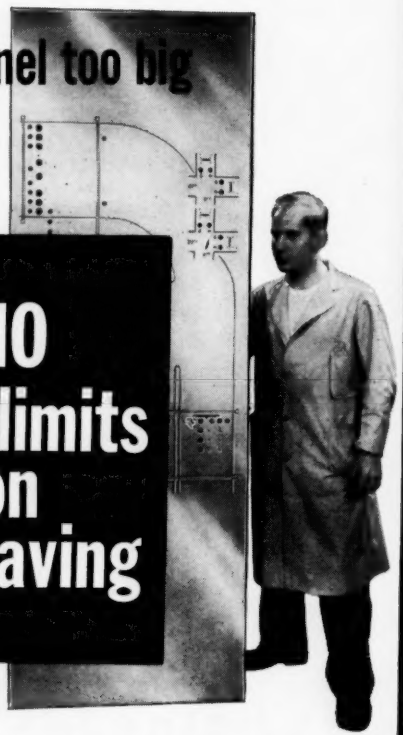
MINNEAPOLIS
Honeywell
HEILAND INSTRUMENTS
5200 EAST EVANS AVENUE • DENVER 22, COLORADO

For more information circle **59** on inquiry card.

Now—

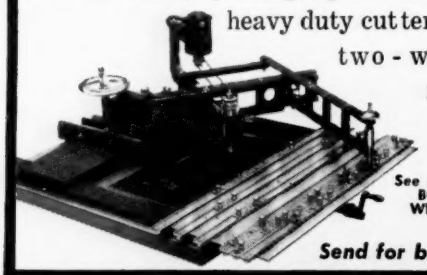
NO plate too small— 213B

NO panel too big



NO size limits on engraving

The new ENGRAVOGRAPH Model I-R takes up only 2 feet of bench space and engraves anything from tiny nameplates to giant panels. Engraving chassis can be detached from base and placed directly on workpiece of any dimension. Smaller plates can be easily clamped in a self-centering workholder which is standard equipment. New sturdy pantograph construction; heavy duty cutter spindle; two-way depth regulator.



See demonstration at BOOTH #2904 WESCON SHOW

Send for booklet XR-1

new hermes ENGRAVING MACHINE CORP.

13-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

NEWS—CONTINUED

GENERAL ELECTRIC has received orders for two Static Switching Systems, one to be used by Inland Steel for a slabbing mill, the other by Southern Pine Lumber Co. in the conversion of wood chips to pulpstack.

GENERAL PRECISION LABORATORY, INC., has been awarded a contract for over $5,500,000 from Air Materiel Command, Wright-Patterson Air Force Base, for quantities of GPL-developed AN/APN-81 Radar Navagational Sets, parts, and associated equipment.

AIRMATIC SYSTEMS has placed a trial installation of an automatic coin retriever at the Jay St., Brooklyn, subway station.

FABRICOMETER, designed by Columbia University scientist, Associate Professor of Astronomy Lloyd Motz, is the textile industry's first wrinkle-measuring instrument.

Nuclear News

Argonne National Lab reports development of a new type fuel potentially useful in nuclear power reactors; ceramic pellets of uraniathoria (UO_2 and THO_2) fuel constituents have been used in a "Borax"-series experimental reactor and have shown advantages over metallic fuel elements.

Atomic International, Div. of North American Aviation, achieved a sustained nuclear chain reaction in the "Sodium Reactor Experiment" (SRE), using neutrons moderated with graphite, and liquid sodium as coolant. The SRE is one of the several different types of reactors in the AEC's program to develop economical civilian power from nuclear energy.

Applied Radiation Corp. (ARCO) recently opened its Western Service Irradiation Center for radiation processing studies by industrial and academic organizations on a rental basis. Its 10-million-electron-volt Mark 1-F2 accelerator produces an electron beam equivalent to 140,000 curies of radioactive cobalt-60, or about one-half of the United States' entire annual production.

The Babcock & Wilcox Co. was commissioned by AEC as prime contractor in the development of a 22,000-shaft-hp pressurized water reactor for a 20-knot passenger-cargo vessel.

General Atomics, Div. of General Dynamics, has received a 10-million dollar contract from the recently organized Texas Atomic Energy Research Foundation to carry out a jointly sponsored research program in harnessing thermonuclear reactions for ultimate economical energy production. It would lead to a practically unlimited energy source contained in the heavy hydrogen (deuterium) in the sea.

New **foreign recipients** of U S Research reactors or nuclear fuel elements under the "Atoms for Peace" program include West Germany (2), and Denmark.

A one-day unclassified **Conference on Reactor Safety** will be held in New York, October 31, 1957. Write to Atomic Industrial Forum, 3 E. 54th St., New York 22, N. Y., for information.

little valves cast big shadows

Among Hoke's achievements with small fluid control products is the standard A431 Packless Valve pictured. We hadn't designed it as such, but this valve is one of our contributions in the field of atomic energy. Radiation Counter Labs utilizes this Hoke valve to introduce radioactive samples into their 4 pi Flow Counter. A little radiation goes a long way, and it takes a pretty hot instrument to count the number of atoms disintegrating per second in a sample. Needless to say, leakage would be inexcusable — what with scattering, self-absorption, secondary radiation, inverted gamma rays and other scandalous goings-on making it rough for the atomic scientist. To prevent such problems, this valve is helium leak tested at the brass bellows seal and air tested at the seat (These are routine tests performed on valves in standard production). Helium seat tests are performed when high-pressure is a factor.

There are many other manufacturers like RCL who consider Hoke valves with the same sense of reliability. Sometimes pressure is the important factor . . . or precise control of flow . . . or even simply attractiveness of design. But whatever the application, producers of quality test and production equipment are cognizant of the craftsmanship in Hoke products; and the users of such equipment often look for Hoke valves as assurance of equipment dependability.

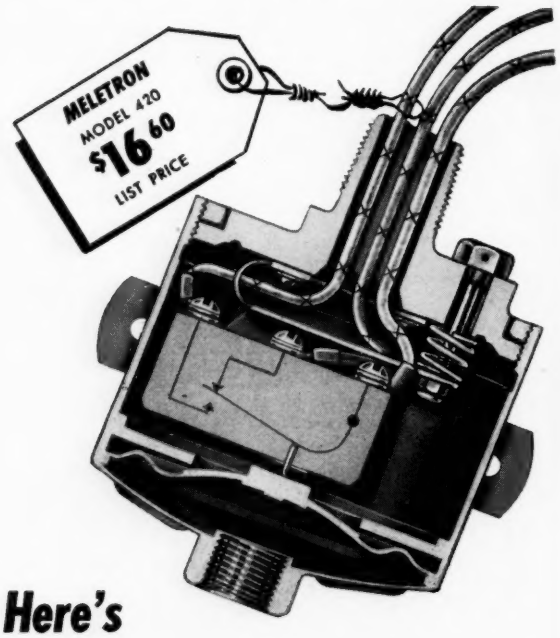
Little valves **do** cast big shadows!

See Hoke Valves at Booth 1316
ISA Show, Cleveland Aud., Sept. 9-13

HOKE, INCORPORATED, FLUID CONTROL SPECIALISTS, 231 S. DEAN ST., ENGLEWOOD, N. J.

OK

For more information circle **21** on inquiry card.



Here's the Simplest Diaphragm Pressure Switch

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletins 420-421

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **22** on inquiry card.

Book Reviews

Servosystems Laboratory Manual, 1957, Educational Services Dept., Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N. Y., 32 p., $2.00. Manual provides an introduction to servomechanisms, feedback control systems, etc.; furnishes framework for introductory lab course for industrial and school use; includes seven basic experiments.

Messen und Regeln in der Chemischen Technik, edited by J. Hengstenberg, B. Sturm and O. Winkler. 1957. Springer-Verlag, Berlin. 1261 p. DM 146. 10 in. A comprehensive treatment with the collaboration of some thirty specialists in various fields. Includes the essential theory. A commendable feature is that the illustrations (1331 in number) are nearly all from line drawings rather than from photographs.

Introduction to Chemistry, by Joseph C. Muhler, Charles C. Rohrer and Ernest E. Campaigne. 1957. Prentice-Hall, Englewood Cliffs, N. J. 452 p. $6.75. 9¼ in. Elementary course intended for students who will specialize in biological work.

Hygrometry, by H. Spencer-Gregory and E. Rourke. 1957. Crosby Lockwood & Son, London S.W. 7, England. 254 p. 365 net. 8½ in. Presents a brief historical survey of the subject, and examines the theory of all types of instruments used in fields where measurement and control of moisture are of importance.

Fundamentals of Chromatography, by Harold Gomes Cassidy. 1957. Interscience Publishers, New York 1, N. Y. 447 p. $9.75. 9¼ in. (Technique of Organic Chemistry, v. 10.) Written with the idea that "all chromatographic phenomena have reasonable explanations which can be discovered," and that "chromatography is based largely on dissymetry—on departure from ideality." Presents principles, with numerous examples of applications. An appendix lists sources of equipment for work in chromatography.

Digital Computer Programming, by D. D. McCracken. 1957. John Wiley & Sons, New York 16, N. Y. 253 p. $7.75. 9¼ in. Written for the reader who needs to know how problems are solved on a modern stored-program computer. Concerned primarily with principles rather than details of any specific machine.

Automation; Its Purpose and Future, by Magnus Pyke. [1957.] Philosophical Library, New York 16, N. Y. 191 p. $10. 8½ in. British book presenting (with minor inaccuracies) in popular style, the development of automation, and its application in various fields including chemistry, accounting, the petroleum industry, transportation, the food industries, guided missiles, and translation.

Analog Computer Techniques, by Clarence L. Johnson, 1956. McGraw-Hill Book Co., New York 36, N. Y. 264 p. $6. 9¼ in. A guide to electronic analog computers (or electronic differential analyzers). Deals in some detail with the use of diodes and differential relays in analog computation. Appendix has a few pages on differential equations.

Continued on page 1428

SYSTEMS 1

BASIC "150" assemblies housed in either vertical mobile cabinets or separate portable cases are available in 1-, 2-, 4-, 6- and 8-channel models. Each is equipped with driver amplifiers of current feedback design and regulated power supplies for *each* channel, and a recorder featuring *nine* extremely accurate paper speeds on 2- to 8-channel models, five on single channel units. Appropriate plug-in preamplifiers quickly and efficiently equip a basic assembly for recording virtually any 0-100 cps phenomena.

new 6- and 8-channel analog readout systems

In addition, complete Sanborn systems from 2- to 8-channels are available for recording analog computer outputs. These are equipped with dual-channel DC amplifiers, for single-ended or push-pull signals — input impedance 5 megohms each input lead to ground — drift less than 0.5 mm/hr. — frequency response down 2 db at 60 cycles for all amplitudes to 4 cm peak to peak. Newest of the computer readout recorders are the 6- and 8-channel console systems (8-channel illustrated — "A" at left). The Model 183 Programmer in a Model 184 case ("B" at left) is optional for use with the 6- and 8-channel consoles. The Programmer automatically turns on chart drive, feeds calibrated signals to all channels, reads computer DC levels, determines the length of record, and shuts off the paper drive.

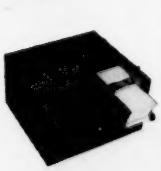
SANBORN

oscillographic recording equipment

2 PREAMPLIFIERS

A choice of *twelve* "150 Series" plug-in preamplifiers is now available, to equip systems for any of numerous recording problems. Improved control of input signals results from attenuator ratios of 1, 2, 5, etc., and calibrated zero suppression on AC-DC, Carrier, and Low Level DC Coupling, Frequency Meter, and Chopper Stabilized DC models. Other "150" preamplifiers include: Servo Monitor, Log-Audio, AC Wattmeter, RMS Volt/Ammeter, 400 cycle Frequency Deviation, and Triplexer.

3 UNIT INSTRUMENTS



All Sanborn Preamplifiers and Recorders, as well as various other units, are available separately for specialized applications or use as "original equipment" in other apparatus. Instruments include the Model 150-300/700 Wide Band Driver Amplifier and Power Supply, for use with low power galvanometer elements, a 'scope and/or panel meter. When equipped with suitable "150" preamplifier, this amplifier provides a portable indicator for strain, force, pressure, temperature, AC watts, audio level, etc. Other units include the Model 150-1900 Master Oscillator Power Amplifier: Model 150-3100 Triplexer; Model 601 and 602 galvanometers; Model 150-2900 Dual-Channel DC Amplifier.

Added to these three aspects of Sanborn Oscillographic Recording Equipment are the basic advantages of inkless recording in true rectangular coordinates, to provide accurate, easily interpreted records; high torque galvanometer (10 ma develops 200,000 dyne cm.); one percent linearity resulting from current feedback driver amplifiers and high torque galvanometers (maximum error is ¼ mm in middle 4 cm of chart, ½ mm across entire chart); controls for timing, manual and remote coding.

Take advantage of the scope and flexibility of Sanborn equipment to answer your recording requirements. Sanborn engineers will be glad to provide further information and application assistance whenever you wish. Contact your local representative or write to the main office below.

"Visit Sanborn Booths 1318-1320 ISA Show, Cleveland, Ohio, September 9-13, 1957"

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN ST. WALTHAM 54, MASS.

For more information circle **23** on inquiry card.

new HAGEN timer permits setting "on" time directly as PERCENT OF CYCLE

MODEL 75
Percent-O-Cycle
TIMER

SAVES SPACE, CUTS POWER LOSS

Only 3-1/2" square at the face, 4-5/16" deep, the Hagen Percent-O-Cycle Timer is a worthwhile substitute for power-wasting rheostats and variable voltage equipment on many applications. Snap action contacts, operated by synchronous motor drive, permit this unit to handle loads up to 25 amps at 125 volts, 60 cycles. Current input into electrically heated furnaces, etc., may thus be efficiently controlled by turning current on for whatever percent of the time cycle is required.

REPEAT ACCURACY 1/10 OF 1%

Easy to read dial makes it possible to set timer to 1/4% of desired setting. "ON" time adjustable from 1-1/2% to 98-1/2% of total time cycle. Standard time cycles: 15, 30 and 60 seconds; 4, 15, 30, and 60 minutes; 2, 4, and 8 hours.

WIDE FIELD OF APPLICATIONS

Stokers, Pumps, Blowers, Lubrication Systems, Dryers and Dehumidifiers are some of the other uses suggested by the Percent-O-Cycle Timer.

Send for new HAGEN Bulletin 1360.

Write Hagen Mfg. Co., Inc. Moline, Illinois, Dept. IA-857.

For more information circle **24** on inquiry card.

BOOKS—CONTINUED

Research and Development in the Corporation. Its Meaning—Its Evaluation. American Institute of Management, 125 E. 38 St., New York 16, N. Y. 93 pages, loose leaf, $12. Covers reasons, expenditures, budgeting, personnel, and other factors relating to private research. Reports that U. S. corporation support of research is less than either reported or needed.

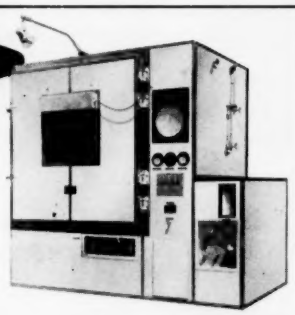
The Instrument Manual. Ed. 2, 1953. United Trade Press, London, E.C.4, England. 628 p. + 103 pages of advertising. £ 4 4s. 11 in. An extensive review of British instrumentation. Twenty chapters deal with instruments, measurement and control in specific fields, each chapter with a bibliography and a buyers' guide. Also has chapters on organizations and publications interested in instrumentation, and includes an alphabetical list of manufacturers and a list of accessories and components, arranged by subjects. First edition was published in 1949.

Electronic Data Processing Industry, by Arthur D. Little, Inc. [C1956.] White, Weld & Co., New York 5, N. Y. 87 p. 11¼ in. Discusses analog computers and their application to problems of engineering design; also digital computers with their greatest potential market in the business world. Deals with technological trends in the industry, lists manufacturers of computers, and includes a glossary.

Blocking Oscillators, edited by Alexander Schure. [C1956.] John F. Rider, New York 13, N. Y. 64 p. unbound. $1.25. 8½ in. Mainly descriptive, divided about equally between operation and applications.

DEVELCO

SALT SPRAY FOG TEST CHAMBER



To meet MIL-E-5272 and others.

TOP OPENING
FRONT OPENING
WALK-IN

Write for Bulletin SS-55

DEVELCO

DEVELOPMENT ENGINEERING COMPANY

9 Cross Street • Norwalk, Connecticut

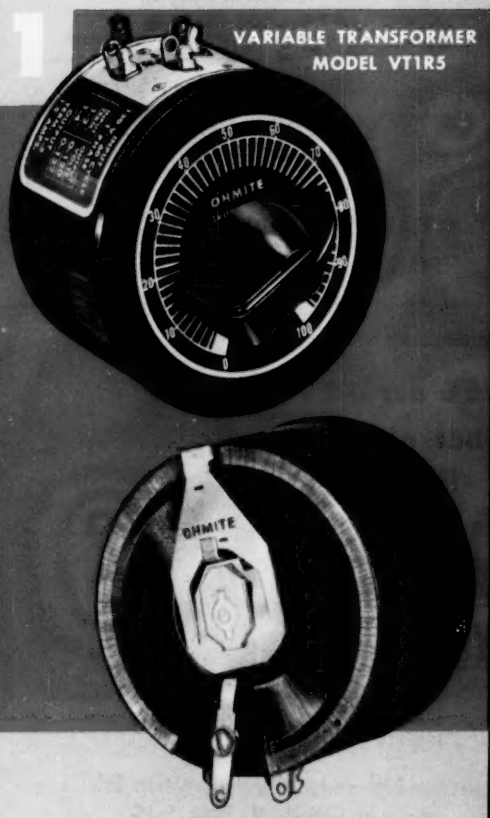
• *Manufacturers of Environmental Test Equipment*
Fungus Testing - Cold - Heat - Altitude - Humidity

For more information circle **224** on inquiry card.

2 new components from OHMITE®

subminiature wire-type tantalum capacitors and variable transformer

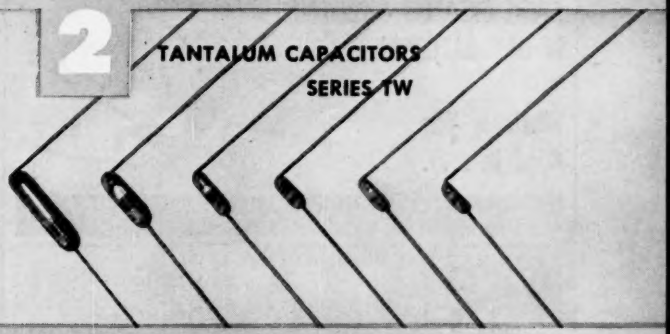
1 VARIABLE TRANSFORMER MODEL VT1R5



MORE CAPACITY FOR EQUAL SIZE

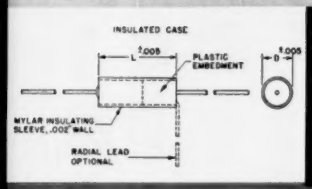
The rating of 1½ amperes represents a continuous rating at any brush setting. This "bonus" in current capacity is the result of a unique core design by Ohmite. The new Ohmite VARIABLE TRANSFORMER model VT1R5 features: Long-wearing, nonoxidizing, rhodium-plated coil contact surface, a ceramic hub that mounts the contact arm, and provides 3000 VAC insulation between parts at line potential and shaft assembly; positive brush to center-lead connection because brush pigtail shunt is bonded into solid copper-graphite slip ring. Input voltage is 120 V, 60 cycle; output voltage is 0-120 V—0-132 V. Mounted by ⅜"-32" bushing and nut. *Write for Bulletin 151.*

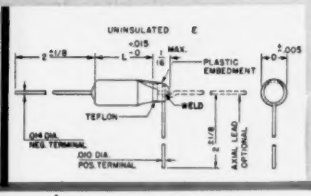
2 TANTALUM CAPACITORS SERIES TW



GREATER CAPACITANCE PER UNIT VOLUME

The new Series TW Ohmite subminiature Tan-O-Mite® TANTALUM CAPACITORS are wire-type units that feature greater capacitance per unit volume, lower leakage current and power factor, and small capacitance drop at extremely low temperatures as compared to other types of electrolytics. Ultrasmall for low-voltage DC transistorized electronic equipment, these new tantalum capacitors have *high stability, high capacitance, long shelf life,* and excellent performance under temperature extremes of −55° C to +85° C. They are available in six *subminiature sizes:* 0.1 to 60 mfd. over-all capacitance range.





SIZE	UNINSULATED		INSULATED	
	D (inches)	L (inches)	D	L
T	.075 (5/64)	.156 (5/32)	.082	.203
S	.075 (5/64)	.187 (3/16)	.082	.234
M	.095 (3/32)	.172 (11/64)	.100	.218
A	.095 (3/32)	.250 (1/4)	.100	.312
B	.125 (1/8)	.312 (5/16)	.134	.375
C	.125 (1/8)	.500 (1/2)	.134	.562

Smallest size is .075 (5/64) x .156 (5/32) inches; the largest is .125 (1/8) x .500 (1/2) inches. Five stock sizes are available in a wide range of capacitances, voltages. Units insulated with a tough Mylar® plastic sleeve can be furnished. *Write on company letterhead for Bulletin 148B.*

BE RIGHT WITH

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3615 Howard Street, Skokie, Illinois

For more information circle **25** on inquiry card.

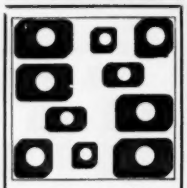
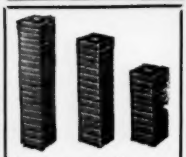
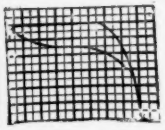
MR. ENGINEER!...

BURGESS

EXCLUSIVE WAFER CELL CONSTRUCTION

GIVES GREATEST SELECTION IN DRY BATTERIES

Whatever You Need in . . .

CAPACITY	VOLTAGE	SERVICE
 A correct cell-size for any capacity.	 Wafer Cell construction produces from 1½ volts on up.	 Burgess will make batteries to fit any application.

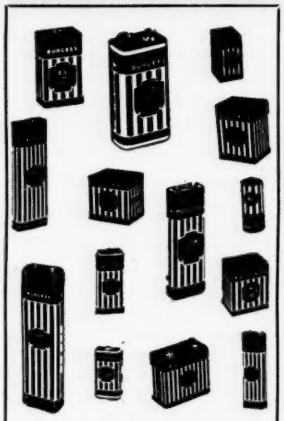
BURGESS

Has The Widest Choice of Dry Batteries Ever Manufactured . . .

The revolutionary Wafer Cell offers a 30% increase in battery life at *no increase in size*. This exclusive Burgess construction consists of a sandwich of manganese dioxide mix between two flat electrodes of zinc and carbon with spots of hot silver wax applied to each exposed pole of the cell, allowing perfect electrical contacts throughout and almost complete absence of vibration. Cells are wrapped in Mylar film and packed in such modern materials as aluminum for compactness, long shelf life, exceptional service life, outstanding dependability.

Burgess design specialists will work out the exact battery to fit your needs. Send your requirements to Dept. E57.

SIZES AND SHAPES



Wafer Cell construction can meet any space, size and weight requirements.

RESERVE BATTERIES

Can be stored dry for years. Activated only when immersed in water. No handling of dangerous electrolyte, no spilling or leaking. Wider range of efficient operating temperatures than any other type of battery.

BURGESS BATTERY COMPANY
FREEPORT, ILLINOIS

For more information circle **26** on inquiry card.

PROCESS CONTROL

by

A. J. Young

Imperial Chemical Industries, Ltd.

". . . the only book that covers all general-purpose controllers of American, British and French manufacturers."

Covers:

control problem
operation of closed-loop
modes of control
& types available

Cloth, 134 + vi, illustrated, 3-page index.

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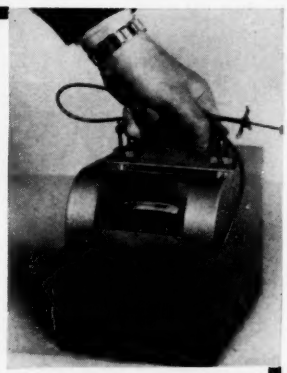
845 Ridge Ave., Pittsburgh 12, Penna.

SEE our NEW but already FAMOUS ASKANIA

UNIVERSAL VIBROGRAPH



And Other Vibration Measuring Instruments at the 12th Instrument-Automation Exhibit in Cleveland, Sept. 9-15

OTHER PRODUCTS:

- SPEED MEASURING INSTRUMENTS
- TEMPERATURE MEASURING INSTRUMENTS
- REFRACTOMETERS
- MELTING POINT TESTER
- PRECISION SPHEROMETER

BOOTH 205

EPIC, Inc. | 154 Nassau Street New York 38, N. Y.

For more information circle **217** on inquiry card.

New ASCO 3-Way Solenoid Valve assures MILLIONS OF TROUBLE-FREE OPERATIONS

NO EQUAL IN SIMPLICITY!

Simplicity is the secret of this remarkable, new 3-way diaphragm valve.
It has *only three operating parts.*
Compare this with the larger number of parts found in conventional 3-ways! That's one reason why the new ASCO valve means trouble-free operation . . . substantial savings in maintenance costs . . . reduction in down-time losses.

SIMPLICITY IN OPERATION

Not only its construction but also its new operating principle is the essence of simplicity: solenoid piloting of two simple diaphragms.

UP TO 400 CYCLES PER MINUTE

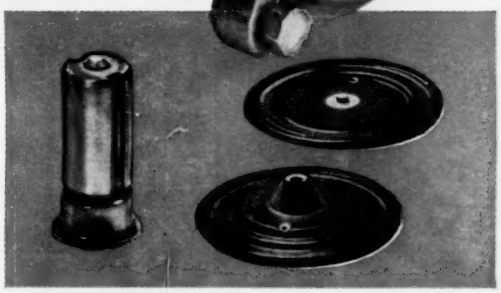
Exceptionally large flow capacity makes rapid recycling feasible . . . cylinders fill and vent rapidly . . . valve operates up to 400 cycles per minute over millions of strokes.

CONVERTS IN 30 SECONDS

Developed for dependable control of liquids and gases, the valve can be converted from normally open to normally closed or the reverse by simple rotation of the valve bonnet.

This new valve is absolutely tight seating . . . no closely fitted parts or valve seat grinding required. Available now in ⅜" and ½" pipe sizes, both with full ⅝" orifices, it can be mounted in any position.

WRITE NOW for your copy of ASCO Bulletin 8316, or have the ASCO Engineer call.



The EXTRA HEAVY FORGED BRASS BODY houses only three moving parts: Two diaphragms and a core. Corrosion protection is assured. All parts in contact with fluids or gases are brass, stainless steel or Buna-N.

ASCO®

DEPENDABLE CONTROL

See Us At The ISA Show Sept. 9-13 Booth #931

Automatic Switch Co. • 52-F HANOVER ROAD • FLORHAM PARK, NEW JERSEY

AUTOMATIC TRANSFER SWITCHES • • ELECTROMAGNETIC CONTROL

For more information circle **27** on inquiry card.

What's your tubing problem?

corrosion?
damage?
installation?
fire? cost?

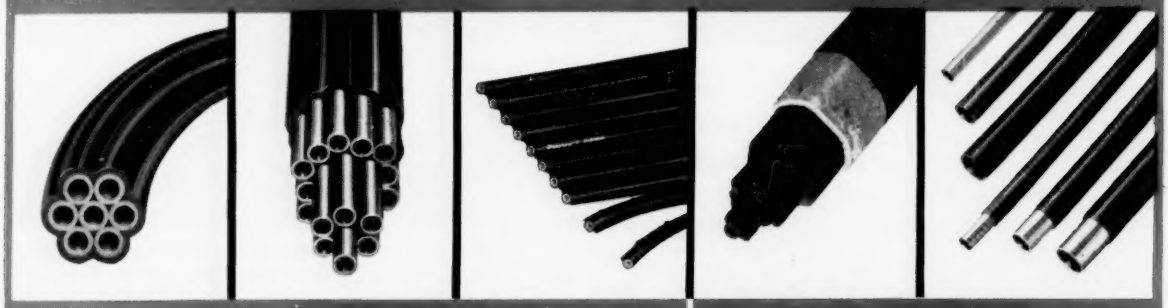
Wherever instrument tubing is used—be it refinery, natural gasoline plant, chemical, nuclear or food processing—Dekoron Tubing Products can help whip your ultimate twin problems of *maintenance-replacement expense and installation costs.*

Why?

First, because Dekoron Tubing products resist chemical attack and corrosion caused by moisture and industrial atmospheres. That means that once installed, Dekoron products are in to stay. You're not faced by perennial replacement and maintenance costs.

Second, the big savings in cost are yours in installation when you specify multiple-line Dekoron products—you install many instrument lines at once.

So if you have an instrument tubing problem of *any sort*, we probably have the answer *in stock*. If not, we can design and make it for you.



POLY-COR
From 2 up to 37 plastic tubes in plastic armor.

METL-COR
From 2 up to 19 copper or aluminum tubes in plastic armor.

RIBBON
M-Ribbon (metal) and P-Ribbon (plastic). 10 tubes in plastic sheath.

PROTECTO-PAC
Fire and impact resistant. Plastic tubes covered with plastic-asbestos-plastic armor.

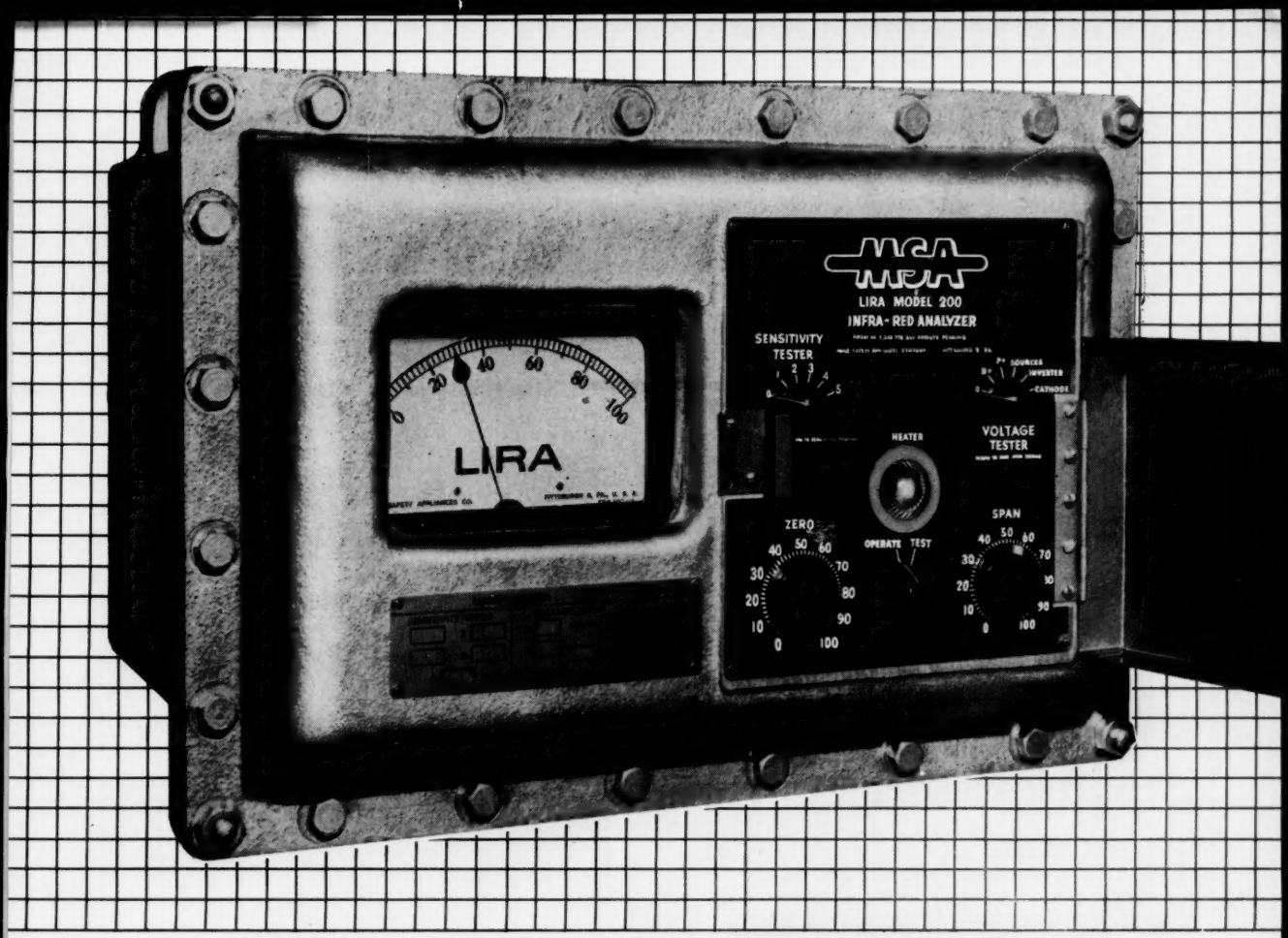
SINGLE-LINE
Single steel, copper or aluminum tubes in plastic armor, or all-plastic tubing.

Dekoron® products
QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & CO.
Dekoron Products Division
MANTUA, OHIO

SEE DEKORON TUBING PRODUCTS ON DISPLAY AT THE CONVENTION BOOTH 1017

For more information circle **28** on inquiry card.



EXPLOSION-PROOF CASE is slightly larger than conventional case and has tamper-proof lock. Amplifier, optical bench power supply and zero calibration controls are all in readily accessible units on a single swing-out chassis.

M-S-A® LIRA Model 200 brings low-cost infrared analysis to process stream control

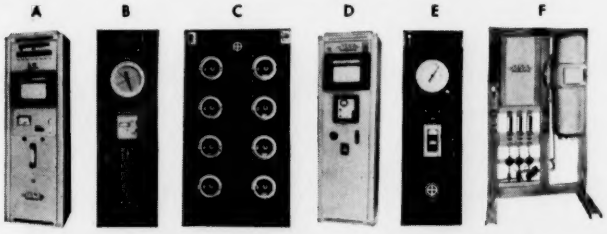
Here's an inexpensive deflection type infrared analyzer for automatic, continuous, high-speed, accurate analysis.

The LIRA Analyzer Model 200 detects one component in a simple or complex mixture of gases or liquids. It's ideal for controlling continuous or batch processes, for determining and controlling product quality, and for measuring toxic and combustible gases or vapors from a few parts per million to 100% of gas.

Built-in facilities check the performance of each part of the system, electrically. Speed of response is 90% of final reading in five seconds. Noise level is less than 1% of full scale. Zero drift is less than 1% of full scale in 24 hours. Accuracy is ±1% of full scale. Warm-up time is 30 minutes.

Design simplicity and small, compact size make service and maintenance quick and easy on the new M-S-A LIRA Analyzer Model 200. Unitized construction makes all controls easily accessible. And for extreme sensitivity, stability and selectivity, the Model 100, incorporating the Null Balance principle, is also available.

Write us for more detailed information on the M-S-A LIRA, or any of our other basic units.



A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Hydrogen Sulphide Recorder
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

MINE SAFETY APPLIANCES COMPANY
Pittsburgh 8, Pennsylvania

For more information circle **29** on inquiry card.

New Plants and Mergers

BOMAC LABS., INC., is building new million dollar plant on Route 128, which will double present capacity.

CONSOLIDATED ELECTRODYNAMICS' Spectron Division has doubled its production capacity by purchasing the optical production and testing equipment of Testa Mfg. Co.

WESTON ELECTRICAL INSTRUMENT CORP. announces move of its Vamistor manufacturing division to new building in Union N. J.

OHMITE MANUFACTURING CO. has started a 42,000 sq-ft addition to existing plant in Skokie, Ill.

COHU ELECTRONICS announces completion of expansion of Kin Tel Div. facilities at San Diego.

PSP ENGINEERING CO. has moved to new plant in Maywood, Calif., tripling former capacity.

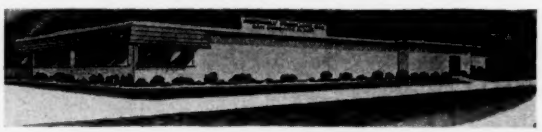
ROBERTSHAW-FULTON CONTROLS CO. has broken ground for new research center at Anaheim, Calif.

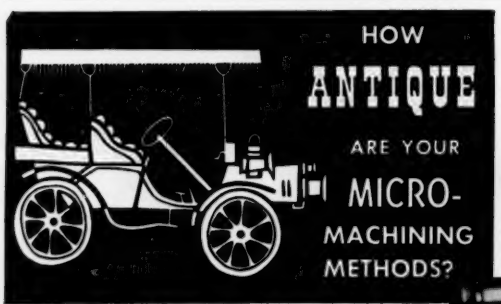
BECKMAN INSTRUMENT, INC., announces formation of a new Systems Division with headquarters at Anaheim, Calif., which brings the number of Beckman's California divisions to seven.

P. R. MALLORY & CO. and **RADIO MATERIALS CORP.** announce agreement to merge interests while operating independently.

AUTOMATIC TEMPERATURE CONTROL CO. will move to new plant located in King of Prussia, Pa., in August, and will assume the new name of Automatic Timing & Controls, Inc.

ASSEMBLY PRODUCTS is expanding its San Gorcinto plant at Desert Hot Springs.





YOU CAN PRODUCE SMALL INSTRUMENT PARTS
WITH MORE
ACCURACY · ECONOMY and SPEED

LEVIN® TURRET LATHES

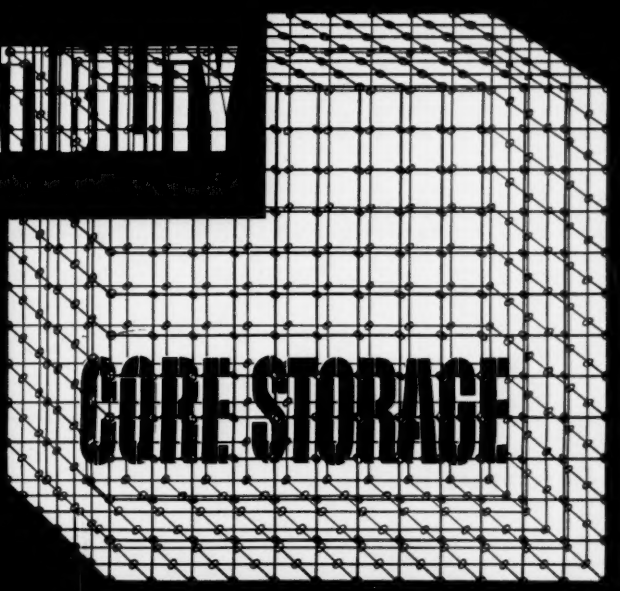
A small precision turret lathe for second operations and production of instrument parts. Available in two collet capacities, 5/16" or 3/16". The 6 position turret is self indexing and has hardened ways. Turret holes are 1/2" diameter. Turret travel 1-5/8". The cross slide has a swivel side at one end and a rigid tool block at the other. Lever collet closer provides quick opening and closing. A variety of turret tools with 1/2" shanks is available.

Send for catalog M describing complete line of instrument lathes, micro-drilling equipment and accessories.

LOUIS LEVIN & SON, INC.—3610 S. BROADWAY—LOS ANGELES 7, CALIFORNIA

For more information circle **30** on inquiry card.

COMPATIBILITY



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MAGNETICS

People IN THE NEWS

Robert L. Rice
Fischer & Porter

Robert Mawson
Consolidated Electrodynamics

R. J. Baumann
Beckman Instruments

John C. Milligan
Kollmorgen Optical

FISCHER & PORTER announces promotion of *Robert L. Rice* to general sales manager, *John Roback* to engineering manager, *C. R. Lambert* to operations manager, and *Norbert Weber* to assist. sales manager Data Reduction and Automation Div.

CONSOLIDATED ELECTRODYNAMICS announces appointment of *Robert R. Mawson* as sales manager of newly created transducer products, *Wellard T. Homes* as director of engineering, and *Roy K. Stephens* as director of manufacturing.

MANNING MAXWELL & MOORE has appointed *John F. Reed* general manager, Consolidated Ashcroft Div.

BECKMAN INSTRUMENTS announces appointment of *Anthony M. Johnson* to product line sales manager, Systems Div., *Robert J. Baumann* to director of marketing, Scientific Instruments Div.

KOLLMORGEN OPTICAL Corp. has named *John C. Milligan* vice-president in charge of sales.

DAYSTROM INC. announces appointment of *Manny Otis* as systems engineer.

JAMES G. BIDDLE CO. has appointed *Philip E. Sellers* sales manager to fill the post vacated by the retirement and death of *Mr. Edward H. Wannemacher.*

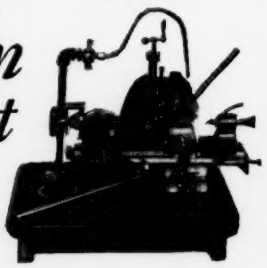
THE BRISTOL CO. has promoted *Walter E. Rufleth* to manager of Telemetering Systems Applications, and *Kenneth R. Neale* to manager of Electronic Products Applications.

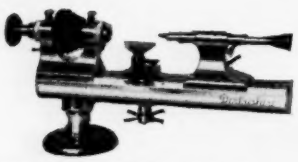
BAILEY METER announces election of *C. E. Sutherland* to vice president, manufacturing; *E. O. Stern* to treasurer and assist. secretary; and H. H. Gorrie to board of directors.

Write for full details

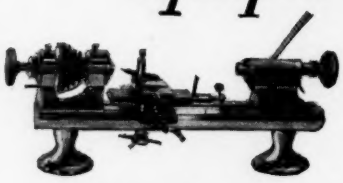
Derbyshire *fine precision equipment*

MICROMILL
2 Table Surfaces: 7⅞" x 2⅜" — 12" x 2⅜" — Takes Magnus Collets.

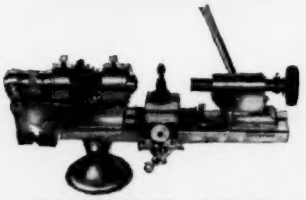




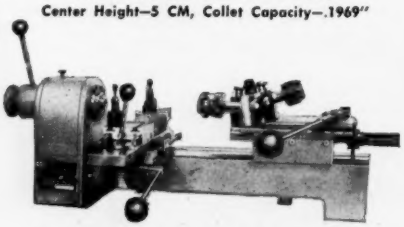
WEBSTER WHITCOMB 12" BED
Center Height—5 CM, Collet Capacity—.1969"



ELECT LATHE — 18" BED
Center Height—2.35" (6 CM)
Chuck Capacity—.004" to .315"



MAGNUS LATHE — 12" BED
Center Height — 5 CM
Collet Capacity — .315"



MODEL No. 750 — 22" BED
Center Height — 7.50 CM, Collet Capacity — .315"

If you have a problem...
. . . concerning small precision turning or milling, one of these lathes or the milling machine shown should solve it. Write for Catalog.

F. W. DERBYSHIRE, INC.
157 HIGH STREET
WALTHAM MASS.

For more information circle **32** on inquiry card.

Tight Control At High Temperatures

When a circular chart recorder was used to monitor temperature regulation in CEC's Chromatograph, the curve showed only slight temperature variations—even less than a guaranteed ±½ °C. With the instrument's temperature absolutely controlled, zero drift in the output signal becomes negligible—a fact very important to accurate measurements. This kind of precision is typical of the Type 26-201's ability to maintain constant sample size, constant carrier flow rate, and constant temperature. Unlike other chromatographs, the 26-201 uses no vacuum tubes. The heated sampling valve eliminates both sample contamination and condensation. Sample volumes are consistently reproducible to better than ±½%. These exclusive features make it practical to use peak height for analytical computations, thus simplifying data reduction. Contact your nearby CEC field office for complete information, or write for Bulletin CEC 1831-X26.

CEC's CHROMATOGRAPH

Provides fast, accurate analysis of almost any mixture, including liquids with boiling points as high as 325°C. Operates with either adsorption, gas-liquid partition, or reaction columns.

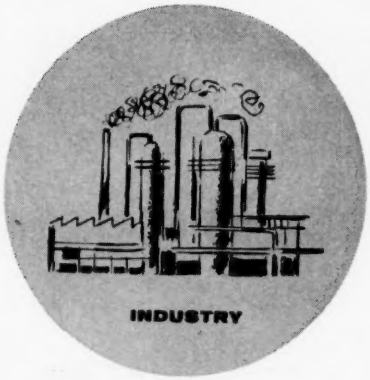
Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

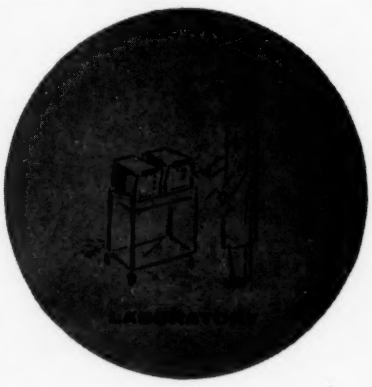
For more information circle **33** on inquiry card.

0.05% accuracy



attainable with

PORTABLE SECONDARY STANDARD



Wiancko Engineering Company announces a new pressure standard for the calibration of pressure instruments, and for direct pressure measurements. The instrument is highly accurate, portable, compact, and covers all normal pressure ranges.

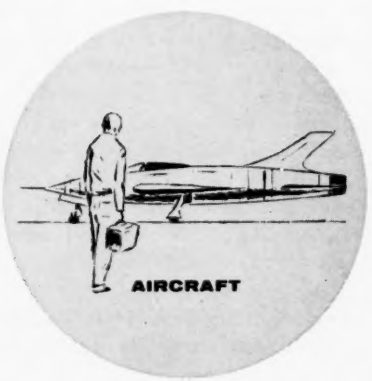
Overall accuracy is ±0.05 percent for full scale ranges of 5 psi to 2500 psi, and ±0.1 percent for ranges of 3000 psi to 10,000 psi.

The light-weight unit, approximately 25 pounds, can be moved about conveniently, or it may be rack-mounted on fixed or mobile racks.

THE SECONDARY STANDARD HAS THESE ADVANTAGES:

1. Interchangeable pressure heads, covering ranges of from 5 psi to 2500 psi absolute and differential, and to 10,000 psi gage pressure.
2. Only one secondary standard is necessary for any number of pressure heads.
3. The output, easily displayed on a frequency counter, is also suitable for recording in digital form on standard digital printers.

The unit consists of a special Wiancko pressure pickup, a precision FM oscillator, and an integral power supply. This secondary standard can, simply and easily, be adapted to measure other parameters such as force, acceleration, and displacement.



Wiancko Engineering Company

255 N. Halstead, Pasadena, California

For more information circle **34** on inquiry card.

wide range available for almost any type of use

MODEL 235N90-35
Designed for fast response and high resistance to the corrosive effects of rocket fuels used in guided missiles.
SPECIFICATIONS:
Stem-sensitive.
Useable temperature range —70° to +200°C.
Exponential time constant in agitated waterbath 0.8 second. Maximum hydrostatic pressure on stem: 750 psi at 100°C.
Basic resistance at 0°C = 90 ohms.
Hermetically sealed.

MODEL 242P
This Detector can be operated in live steam or high temperature atmospheres up to 1300°F.
SPECIFICATIONS:
Stem-sensitive.
Useable temperature range —70° to +750°C.
Maximum hydrostatic pressure on stem: 300 psi at 750°C.
Basic resistance at 0°C = 100 ohms.
Hermetically sealed.

MODEL 230N
A general purpose Detector for temperature measurement and control in industrial processes.
SPECIFICATIONS:
Stem-sensitive.
Basic resistance at 0°C = 120 ohms.
Hermetically sealed.

MODEL 166NC
Element is concentrated in tip for sensitivity to surface temperatures in motor bearings, etc.
SPECIFICATIONS:
Tip-sensitive.
Useable temperature range —70° to +300°C.
Basic resistance at 0°C = 120 ohms.

Rugged Edison RTD's are now available in 48 different types for use within indicating, recording, controlling and monitoring equipment. Adaptability of design and materials assures the construction of the best unit for each individual application.

Edison RTD's show marked advantages over conventional methods of resistance thermometry in any one of its many applications including: aircraft, missiles, missile fuels, pumps, motors, or anywhere temperature must be controlled and monitored. For one thing, they do not require signal amplification because they carry a potential of 1.5 volts sufficient to give an immediate indication on any type of instrumentation. For another, they give a time constant of less than ½ second because of their design (electrical bridge type) — a response time much faster than most industrial thermometer bulbs encountered.

The accuracy of metal RTD's is so great that the platinum RTD is the international standard between —190 C and +660 C. Edison RTD's tested years after manufacture show less than ± .05% change from the original calibration.

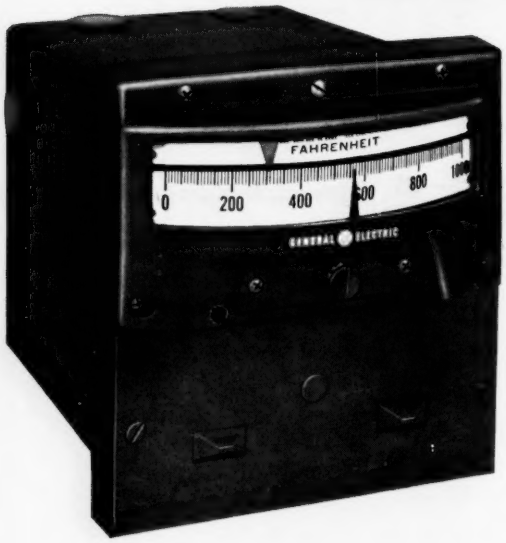
It will pay you to investigate the advantages of using Edison RTD's in your present or proposed temperature control work. Write for Brochure #3016.

McGRAW EDISON

For more information circle **35** on inquiry card.

PROCESS INSTRUMENTS

New HP-30 Pyrometer provides ±.5% accuracy, automatic lead length compensation, and features printed circuits



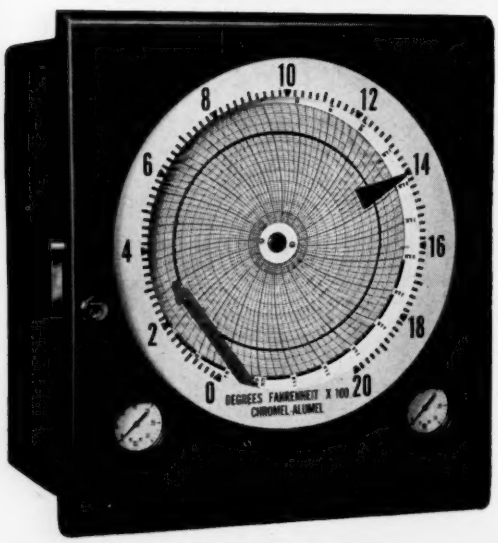
PRINTED CIRCUITS AND MINIATURE COMPONENTS mean a smaller pyrometer (new size: $7\frac{9}{16}$ inches x 8 inches) and savings on valuable panel space.

AUTOMATIC LEAD LENGTH COMPENSATION up to 25 ohms in low ranges and 90 ohms in higher ranges is an exclusive feature on the new HP-30 Pyrometer.

±.5% ACCURACY AND .1% TO .5% SENSITIVITY MAINTAIN THE HIGH ACCURACY and close sensitivity associated with General Electric pyrometers.

NEW INTERCHANGEABLE CONTROL FORMS, including the all-electronic time-proportioning control, allow maximum flexibility.

HE Recorder-Controller gives ±.25% accuracy, continuous standardization, has widest ambient operating range



CONTINUOUS STANDARDIZATION provides an unchanging reference for close control and lower maintenance, through the elimination of dry cell, standard cell, and conventional standardizing circuit.

HIGHER ACCURACY REFERENCE JUNCTION provides measurement accuracy unaffected by changing ambient temperatures.

REMOTE TRANSMISSION of signal from recorder is available at no additional cost.

WIDEST AMBIENT OPERATING RANGE from 0 to 125 F.

ALSO AVAILABLE are a-c bridge recorders and multi-point precision indicators, pneumatic or electric control, electric programming control and sensing devices for measuring temperature, pH (acidity), power, speed, and other variables for continuous process industries.

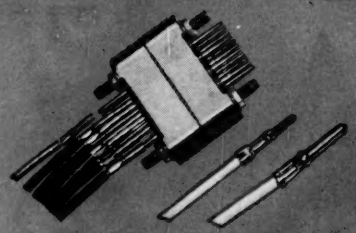
FOR FURTHER INFORMATION, write to Section 587-10, General Electric Co., Schenectady 5, N. Y. for your free copies of bulletin GEC-1377 (HE RECORDER-CONTROLLER) and bulletin GEC-1449 (HP-30 PYROMETER). Or you can contact your nearest General Electric Apparatus Sales Office.

GENERAL ELECTRIC

For more information circle **36** on inquiry card.

IT'S ROUND-UP TIME AT AMP

. . . products for your ELECTRONICS and AVIONICS applications



TAPER PINS

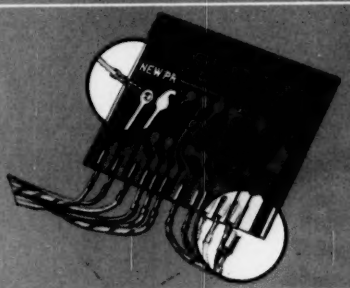
The A-MP Miniature Taper Pin Receptacle eliminates tedious and costly operations of soldering leads to miniature connectors. This solderless, quick-disconnect terminal is applied to the lead by means of A-MP Automachine and A-MP Certi-Crimp Tooling . . . then capped over other type connectors, modified to receive the A-MP 37 Series Miniature Taper Pin Receptacle.

Other A-MP Taper Pins are available (Series 53 and 88) for wire sizes 24 - 12 AWG and a wide range of insulation sizes. Insulation piercing Taper Pins are available for small stranded wires and popular size tinsel cords.

TAPER TAB RECEPTACLES

A-MP Taper Tab Receptacles are a recent development for flat tabs employing the taper key principle. They are available for wire sizes 24 - 18 AWG, in gold, silver and tin plated finishes.

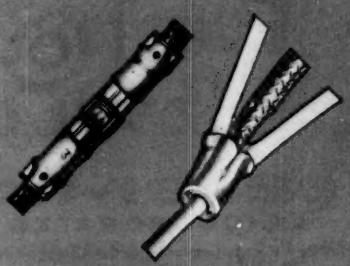
The tapered section of these receptacles is standardized to fit the same size tapered tab. Insulation piercing Taper Tab Receptacles are available for small wire sizes and tinsel cords.



CONNECTORS FOR PRINTED CIRCUITS

The AMP-Edge Connector is design-engineered with positive wiping contact and frictional grippage. This connector gives you: greater flexibility . . . its size does not limit the size of your completed unit; design versatility . . . easily applied, in any arrangement, to any section of the perimeter; costs reductions . . . in applying connector to the wire and to the printed circuit.

The AMPin Connector . . . gets leads to the printed circuit in one assembly operation . . . eliminates your investment in expensive automation equipment . . . no loose leads during the solder-dip process . . . construction promotes good capillary flow of solder during dipping process . . . can be applied to solid or stranded wires . . . is self-retaining and self-aligning.



THE SHIELDED WIRE TEAM

The A-MP Shielded Wire Splice joins sections of shielded wire so that the inner conductor and outer shield are firmly spliced and remain effectively insulated from each other. Features include: rectangular inspection window, in center, permits easy inspection to determine proper placement of ends of inner conductor; inspection ports, at each end, to check proper depth of braid enclosed after crimping; and overhang of outer sleeve projects beyond inner elements and grips braid for anti-vibration support.

The A-MP Termashield Shielded Wire Ferrule are of one-piece construction, is slightly thicker than the wires joined, and is the ideal one-step splice for ground tap accommodation.

This A-MP Shielded Wire Team is color-coded for easy identification of leads and connectors and provides a simple one-step operation that reduces assembly time and costs.

Further information on these products is available on request.

AMP INCORPORATED

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Aircraft-Marine Products (Great Britain) Ltd., London, England
Société AMP de France, Le Pre St. Gervais, Seine, France
AMP—Holland N.V. 's-Hertogenbosch, Holland
DISTRIBUTOR IN JAPAN: Oriental Terminal Products Co., Ltd., Tokyo, Japan

General Offices:
3722 Eisenhower Blvd.
Harrisburg, Pa.

AMP

Visit us at the WESCON SHOW Aug. 20-23, 1957 Booth Nos. 2319-2320.

For more information circle **37** on inquiry card.

FLASH...
an *Original Idea!

You Can Count On... to Pay Off!

It's the **Original Equipment* idea . . . which simply means that, when you're figuring on electrical or mechanical counters in any new product, it pays to *design them in, when you begin.*

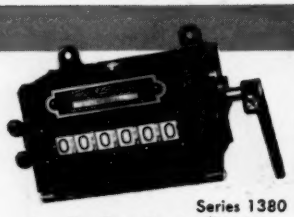
For then Veeder-Root quite likely can save you time and money by adapting or modifying a *standard* counter to your needs, instead of a special which you might specify on your own. This solves the counter problem . . . and saves you time in engineering, purchasing and assembly.

What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin* . . . it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

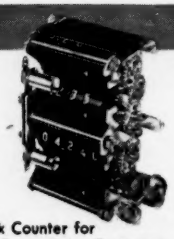
Series 1205
Reset Magnetic Counter

Everyone Can Count on Veeder-Root
INCORPORATED

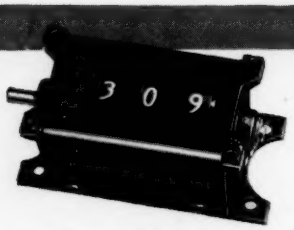
Hartford, Conn. • Greenville, S. C. • Chicago • New York
Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities



Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)



4-bank Counter for Radio Transmission Equipment



360-degree Bearing Counter

For more information circle **38** on inquiry card.

NEW! direct tank-mounted LIQUID LEVEL TRANSMITTER

Exclusive static pressure connection for closed vessels above or below atmosphere . . . eliminates need for second instrument.

This sensing diaphragm capsule flange-mounts directly on side of tank. All wetted parts of Type 316 stainless steel, with optional plastic coating for further corrosion protection.

with DIRECT 3-15 psi air output signal

IDEAL FOR: Viscous or corrosive fluids, slurries, and solids-in-suspension, as well as "easy-to-measure" fluids.

Now you can measure the level of "difficult" or easy-to-measure fluids — economically, without the complication of floats or bubble tubes, and with *sustained high accuracy over the entire range span.*

Flange-mounted directly to the side of an open or closed tank, the Type 13FA Transmitter eliminates piping and purging. Its stainless steel diaphragm capsule senses level changes instantly. Conventional tubing leads its output air signal directly to standard 3-15 psi receiver-recorders and controllers without need for intermediate signal converters.

The 13FA provides an accurate, trouble-free solution for level measurement problems. Write for detailed information, or ask your nearby Foxboro Field Engineer to explain its application to your specific process. **The Foxboro Company, 468 Neponset Ave., Foxboro, Mass., U.S.A.**

FOXBORO

REG. U.S. PAT. OFF.

LIQUID LEVEL TRANSMITTERS

For more information circle **39** on inquiry card.

Astounding

NEW
PERFORMANCE

MIDWESTERN

DIRECT RECORDING OSCILLOGRAPH

DR*

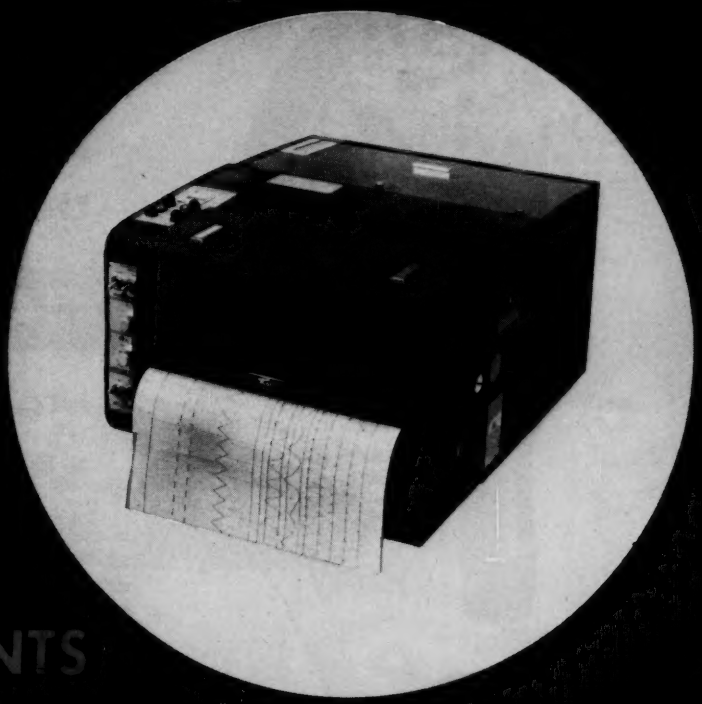
601
602

*DIRECT READOUT WITHOUT PROCESSING
SELF-DEVELOPING • DRY • NO CHEMICALS

SPECIFICATIONS

MAXIMUM NUMBER OF CHANNELS	Model 601—36 Channels Model 602—50 Channels
RECORD WIDTH	Model 601— 7 inches Model 602—12 inches
MAGAZINE CAPACITY	Model 601—150 feet Model 602—200 feet
RECORD SPEED RANGE	0.0812 to 129.9 inches per second
FREQUENCY	dc to above 3,000 cps
WRITING SPEED	Above 30,000 inches per second
OPTICAL ARM	11 inches
POWER REQUIREMENTS	110 volts—60 cps
TIMING LINES	0.01 and/or 0.10 second intervals
SIZE	Model 601—11 1/16" x 11 9/16" x 23" Model 602–11 1/16" x 16 13/16" x 24 1/2"
WEIGHT	Model 601— 90 pounds Model 602—130 pounds

For more information circle **40** on inquiry card.



5 EXCLUSIVE ADVANCEMENTS

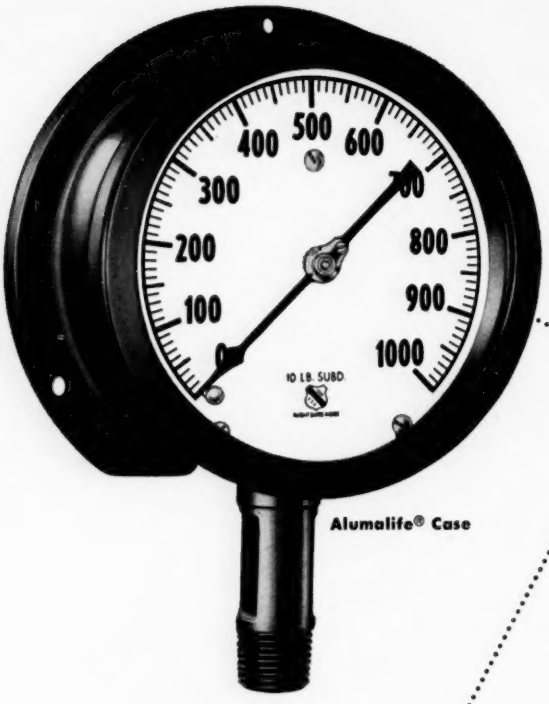
* *Up to 50 channels of information*
* *Uses standard 102 Galvanometers*
* *Provides timing lines, record numbering and many other advancements*
* *30,000 inches per second writing speed with excellent legibility dc to above 3,000 cps*
* *Seven inch or twelve inch records*

Wire for Brochure: **FAX-FCB/TULSA**

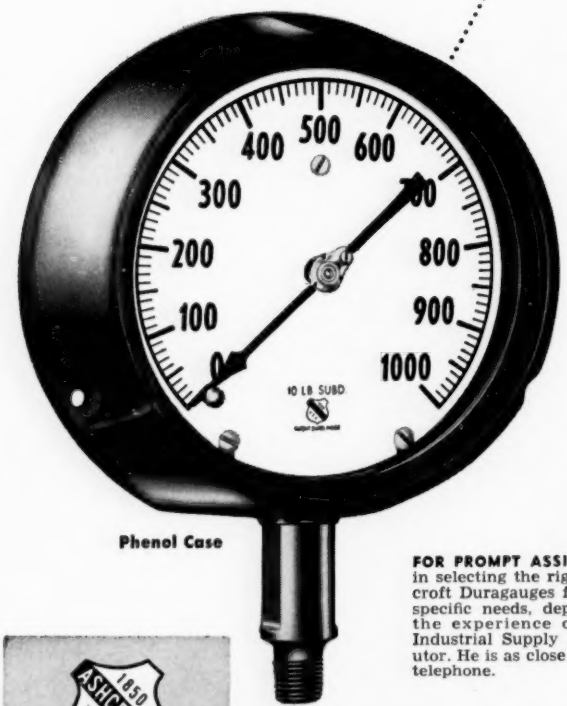
MIDWESTERN
INSTRUMENTS

P O BOX 7186 TULSA, OKLAHOMA

For more information circle **40** on inquiry card.



Alumalife® Case



Phenol Case

Why do ASHCROFT DURAGAUGE CASES increase service life?

Duragauge casings add extra-long service life to Duragauges because they're available in three different materials: you can choose the case-material that stands up best in *your application.* You have a choice of *Alumalife®* – a special aluminum alloy; *Cast Iron,* rugged and durable; and *Phenol,* a tough, rigid plastic.

Duragauge casings are dust and moistureproof. Chrome-plated, die-cast retaining rings keep the dial cover glass tightly in position and prevent the entrance of dirt or harmful fumes. Depending upon material, casings are Bonderized and the ring is Anodized and dichromate sealed for protection from corrosion.

For added protection, there is the Maxisafe Duragauge casing with a solid front – a special design for maximum safety and ease of maintenance. Duragauges are easy to service since Duragauge casings are constructed so that the entire system – socket, tube, tip, movement, dial and pointer—can easily be removed as a unit.

Lifetime Duragauge cases are available for numerous dial sizes. You have a choice of Bourdon tube materials, a wide range of pressures, and a movement made completely of stainless steel or stainless steel with nylon bearings and pinion gear.

Whatever case material and gauge system is best for your needs, you can rely on the Ashcroft Duragauge for highest sustained accuracy and long service life.

FOR PROMPT ASSISTANCE in selecting the right Ashcroft Duragauges for your specific needs, depend on the experience of your Industrial Supply Distributor. He is as close as your telephone.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

G4-56

For more information circle **41** on inquiry card.

Why **DYNALOG*** *design is out front of all electronic potentiometers . . .*

IT'S THE MAINTENANCE MAN'S DREAM!

Advance features to improve control of temperature, pressure, flow . . .

1. No periodic maintenance
2. No dry cell—no standardizing
3. No high-speed moving parts
4. No slidewire or galvanometer
5. *Stepless*, continuous balancing
6. Adaptable to narrow spans

FOXBORO
REG. U.S. PAT. OFF.
DYNALOG
ELECTRONIC INSTRUMENTS

Yes, you can actually eliminate the continual inspection and maintenance usually required by balancing-type process control instruments! DYNALOG Electronic Instruments provide *uninterrupted* evaluation of many process variables . . . *sustained* high accuracy. DYNALOGS are inherently free from "drift" or mechanical problems . . . have no dry cells to standardize or replace . . . require no lubrication or alignment. They're dustproof, vibration-proof, foolproof.

This troublefree performance is a direct result of the unique DYNALOG Design. No troublesome slidewire and balancing motor . . . just a simple, variable radio-type capacitor and positive magnetic drive. The friction-free system responds instantly . . . gives unmatched smoothness of balancing . . . years of faultless service. DYNALOG Instruments are used with any primary element — resistance, voltage, capacity, inductive — wherever there's a precise control or recording job to be done. For the complete story, write for Bulletin 20-10. **The Foxboro Company, 468 Norfolk St., Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

For more information circle **42** on inquiry card.

NOW . . . with one unit—

You can standardize both AC and DC instruments with General Electric's Standardization Console

THE MOST COMPLETE SINGLE FACILITY AVAILABLE—General Electric's instrument standardization console—provides regulated power supplies for high-accuracy standardization, or calibration, of practically all types of a-c and d-c measuring instruments.

COMPLETELY SELF-CONTAINED, the General Electric console offers fast...easy ...economical standardization, particularly where rigid accuracy and periodic checks are required...helps reduce downtime losses and expense in standardizing working instruments, or dismantling, packing, and shipping instruments to an outside source for standardization...and minimizes instrument inventory needed for emergency replacements and purchased standardizing service.

EASY-TO-OPERATE console features simplified job-centered controls for rapid standardization by non-skilled workers... and provides safety features that make it virtually impossible to damage the instruments "on test," the standards, or the console.

EXTREMELY ACCURATE MEASUREMENTS . . . both a-c and d-c . . . console d-c measurements are accurate to 0.01 per cent; a-c measurements to 0.05 per cent, depending on reference standards used. You can select the accuracy class best suited to your needs.

HIGHLY VERSATILE, the general-purpose console permits use of the "transfer standards" method for greatest accuracy and the "comparison" method for general standardization work...specific procedures can be set up to meet your particular objectives or requirements.

POWER SOURCE STABILITY and control resolution are designed to vary rigid limits. Regulated power is supplied in the audio-frequency range of 50 to 3000 cycles per second...both a-c and d-c current and voltage supplies are provided in conventional separate bus facilities up to 150 amperes, 750 volts. Single power input-115 volts, 60 cycles, 30 amperes.

FOR FURTHER INFORMATION, write: Section 585-70, General Electric Company, Schenectady 5, N.Y., or call your nearest General Electric Apparatus Sales Office.

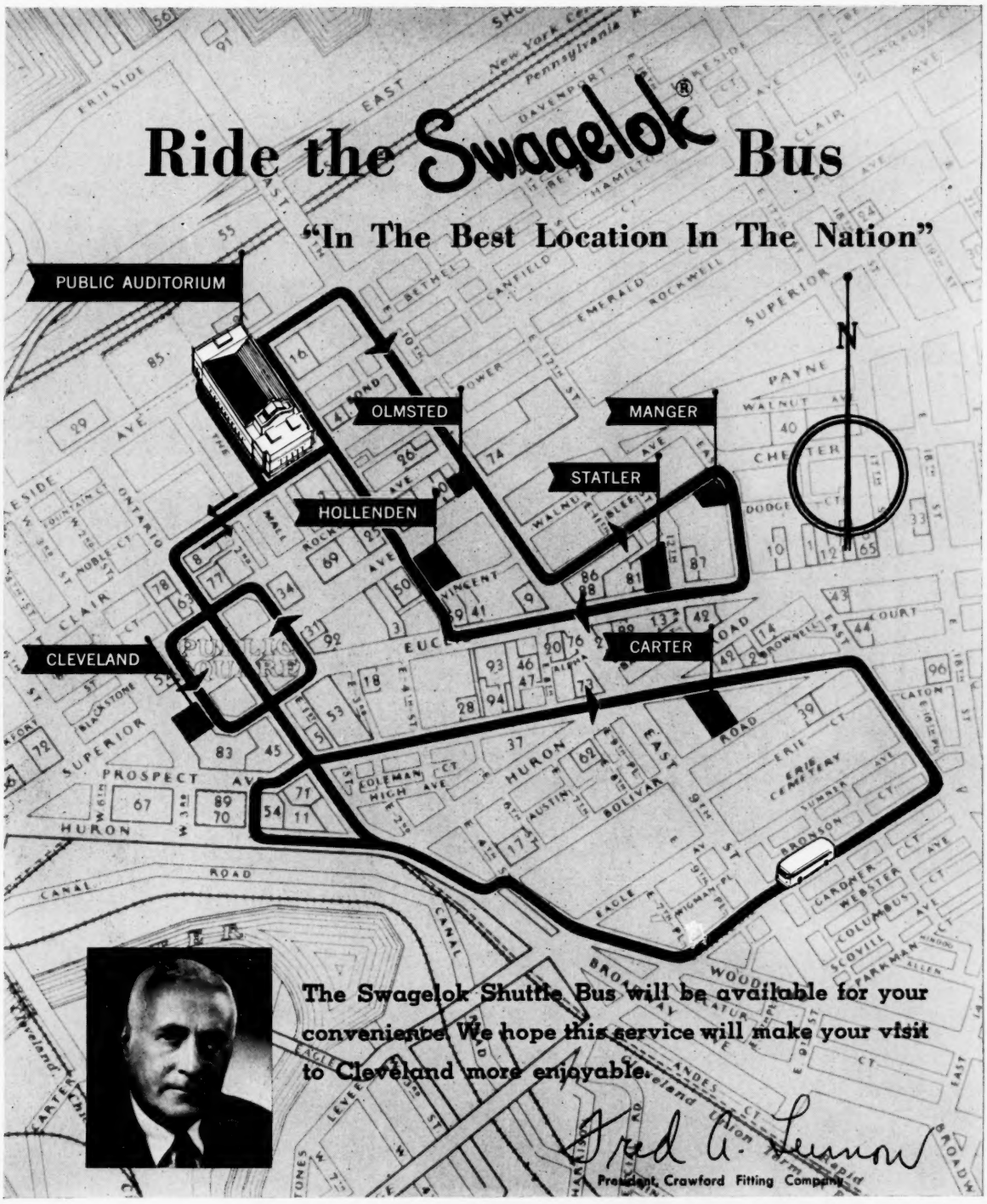
THE STANDARDIZATION CONSOLE WILL BE DISPLAYED AT THE WESCON SHOW, SAN FRANCISCO, AUG. 20–23.

GENERAL ELECTRIC

For more information circle **225** on inquiry card.

Ride the Swagelok® Bus

"In The Best Location In The Nation"



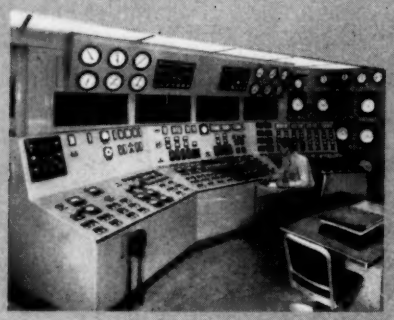
The Swagelok Shuttle Bus will be available for your convenience. We hope this service will make your visit to Cleveland more enjoyable.

Fred A. Lennon
President, Crawford Fitting Company

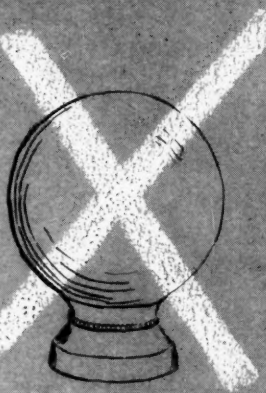
The free Swagelok Shuttle Bus Service will operate during conference and exhibit hours between hotels in downtown Cleveland and the Public Auditorium. Departure times and boarding locations will be displayed in your hotel lobby.

CRAWFORD FITTING COMPANY • 884 East 140th Street, Cleveland 10, Ohio

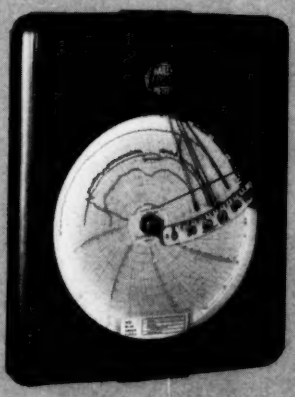
For more information circle 43 on inquiry card.



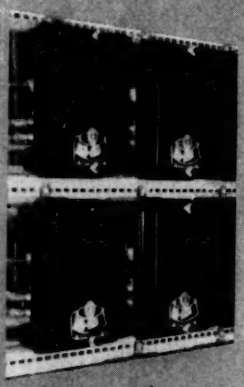
controlling



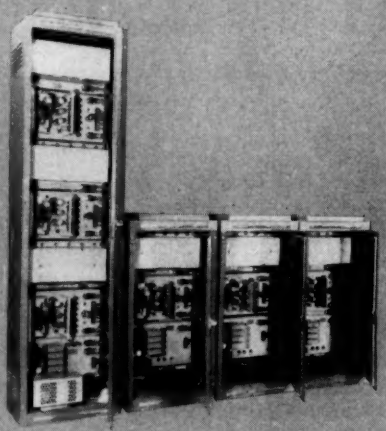
performance monitoring



indicating-recording



measuring



data logging

For more information circle **44** on inquiry card.

If measuring were impossible, you'd be guessing, wishing, & betting...

. . . and no matter how confident you were, it would never be good enough . . . because process plant systems engineering requires *measuring*, all the way from indicating to data logging.

. . . and *measuring* is our backbone. Bailey Meter can offer you over 40 years of experience in design and application. And now this experience in measurements has perfected a complete line of process plant instrumentation.

Indicators and recorders, controlling instruments, performance monitors, data logging equipment—a complete line of electric and pneumatic equipment for whole or partial control and information systems, for partial or complete process plant performance.

Your system will have *building block* flexibility with Bailey equipment. You can add to it as you feel the need, because Bailey uses standardized, compatible components. Our complete line gives you one-source buying . . . one responsibility . . . fast service . . . competent field assistance on one instrument or on a complete systems engineering job.

Call our nearest office or write for information today. G45-2

Instruments and controls for power and process

BAILEY METER COMPANY

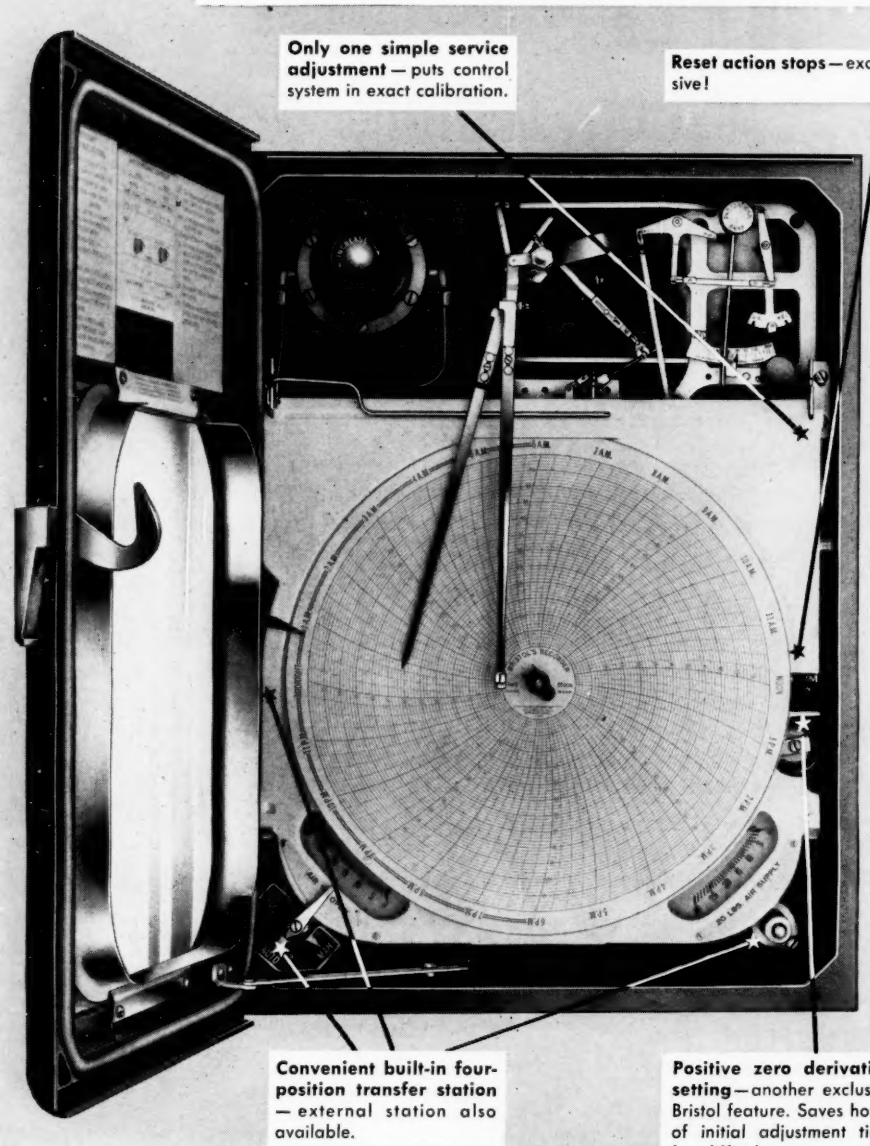
1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

A complete line of Bailey equipment will be exhibited at the I.S.A. Show

For more information circle **44** on inquiry card.

Are you sure you


Only one simple service adjustment — puts control system in exact calibration.
Reset action stops — exclusive!
Convenient built-in four-position transfer station — external station also available.
Positive zero derivative setting — another exclusive Bristol feature. Saves hours of initial adjustment time for difficult processes.

MADE IN MODELS FOR THESE CONTROL MODES:

1. **Fixed narrow band** (on-off).
2. **Proportional**—to 100% and to 30%.
3. **Reset with wide band**—rates 0.1 to 10 or 1 to 300 repeats per minute. Proportional band to 400%.
4. **Derivative** (rate)—Derivative time 0.2 to 20 min., plus zero derivative setting.
5. **Reset plus derivative**—proportional band, reset rate and derivative time as shown above.

WILL HANDLE THESE CONTROL PROBLEMS:

1. Cascaded control
2. Selective control
3. Ratio control
4. Time-program control
5. Pneumatic transmission.

For more information circle **45** on inquiry card.

are getting the best in pneumatic controllers?

Before you buy another controller check these advantages of the new Bristol Series 500 Free-Vane® Pneumatic Controller

FINEST MEASURING ELEMENTS

Bristol Series 500 Pneumatic Controllers are equipped with precision Bristol measuring elements—the widest selection of high-quality measuring elements available with any line of control instruments. You'll find models for control of: **temperature, pressure, vacuum, draft, absolute pressure, liquid level, flow, humidity, density, pH, and a large number of other variables measurable with electronic potentiometers and bridges.**

The sustained, predictable performance of Bristol measuring elements is one reason why you'll find more Bristol recording pressure gauges in use *than all other makes combined.* The new, completely linear Bristol Dual-Filled Vapor Pressure Measuring Element used in Series 500 Thermometer Controllers is the first really big advance in this field of measurement in 25 years. The Bristol Absolute Pressure Element, available in ranges as low as 0-6 mm of mercury absolute, also leads in its particular field. These are just a few of many examples of Bristol leadership in the development and improvement of measuring elements.

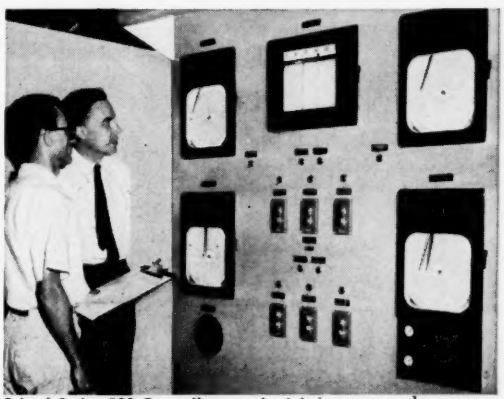
ADVANCED CONTROL SYSTEM FEATURES

Many features *found on no other pneumatic controller* assure better control with the Bristol Series 500: Reset action stops on reset models prevent loss of control due to prolonged deviation from set point; true zero derivative setting (on derivative models) can save hours of initial adjustment time; easy shift to wider proportional band (½ to 200% or 1 to 400% on wide band models) *without recalibration.*

BEST MAINTENANCE RECORD

One simple adjustment puts a Series 500 controller in exact calibration.

Basic simplicity, accurate design, closely held manufacturing tolerances make this single adjustment all that's necessary—even after complete disassembly and reassembly with replacement parts.



Bristol Series 500 Controllers on the job in new modern processing plant. Absolute pressure, steam flow, and liquid levels are variables controlled here.

This practically "built-in" calibration is typical of the foresight and engineering planning that make the Series 500 the easiest pneumatic control system on the market to service. Cut-and-try methods are eliminated. No special maintenance skills are required. All parts are completely interchangeable. The result: a truly superlative maintenance record in thousands of industrial plants.

NATION-WIDE SERVICE

Series 500 Controllers are backed up by the kind of service a quality product requires. The facilities of the main factory, four strategically-located branch factories, and factory-trained service engineers operating out of 44 principal cities across the United States and Canada are on call whenever and wherever needed to help you get the most out of your Bristol Pneumatic Controllers.

GET COMPLETE INFORMATION

. . . on the Bristol Series 500 Pneumatic Controller before you buy another instrument! Fully described in Bulletin A130. Write: The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 6.76

**T.M. Reg. U. S. Pat. Off.*

Come and see us at the I.S.A. Show in booths 918 thru 930.

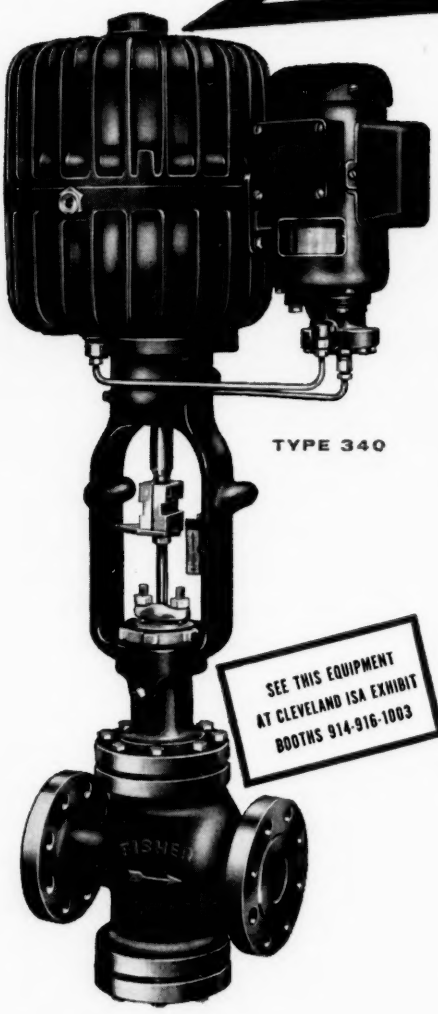
BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **45** on inquiry card.

Introducing FISHER ELECTRO-



Recent trends toward electrical control loops have created a need for final control elements capable of utilizing their greater sensitivity and speed. Fisher Electro-Hydraulic Operators are self-contained, electrically operated valve actuators, ideal for use in such control loops. They produce high performance without the use of electronic amplification, utilizing only a simple DC electrical circuit to control the hydraulic pilot. The pilot systems incorporate no close fitting parts, but use simple nozzle-flapper combinations to control hydraulic pressure.

Two sizes are available. To handle the most demanding control jobs Type 350 has a maximum stem thrust of 2000 pounds and is available for use on valve sizes ½″ to 16″ with strokes from ½″ to 3″. Type 340 is designed for the average control job. It has a maximum stem thrust of 600 pounds and is available for use on valve sizes ½″ to 4″ with strokes from 7/16″ to 1½″.

Rugged, simple design plus accurate, dependable performance, make the FISHER Electro-Hydraulic Operators the outstanding electric final control elements available.

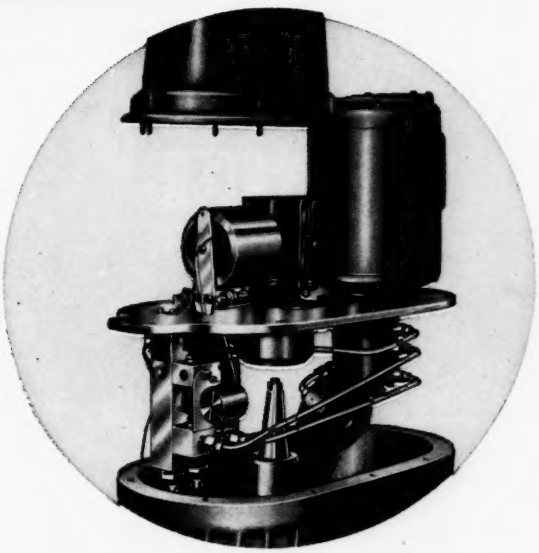
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND

FISHER GOVERNOR COMPANY

For more information circle **46** on inquiry card.

HYDRAULIC OPERATORS

TYPE 350



TYPE 340

- Adaptable to all DC output signals
- Requires only zero and travel adjustment (both readily accessible)
- Stroking range from 7/16" to 1½"
- Stroking speed 0.1"/sec.
- Resolution sensitivity—0.2% of input range
- Maximum stem thrust 600 pounds
- Operates on simple DC—no electronic amplification
- Valve sizes from ½" to 4"

TYPE 350

- Adaptable to all DC output signals
- Requires only zero and travel adjustment (both readily accessible)
- Stroking range from ½" to 3"
- Stroking speed 0.37"/sec.
- Resolution sensitivity—Better than 0.05% of input range
- Maximum stem thrust 2000 pounds
- Operates on simple DC—no electronic amplification

Valve sizes from ½" to 16"

LIQUID LEVEL CONTROL

FISHER®

Marshalltown, Iowa / Woodstock, Ontario

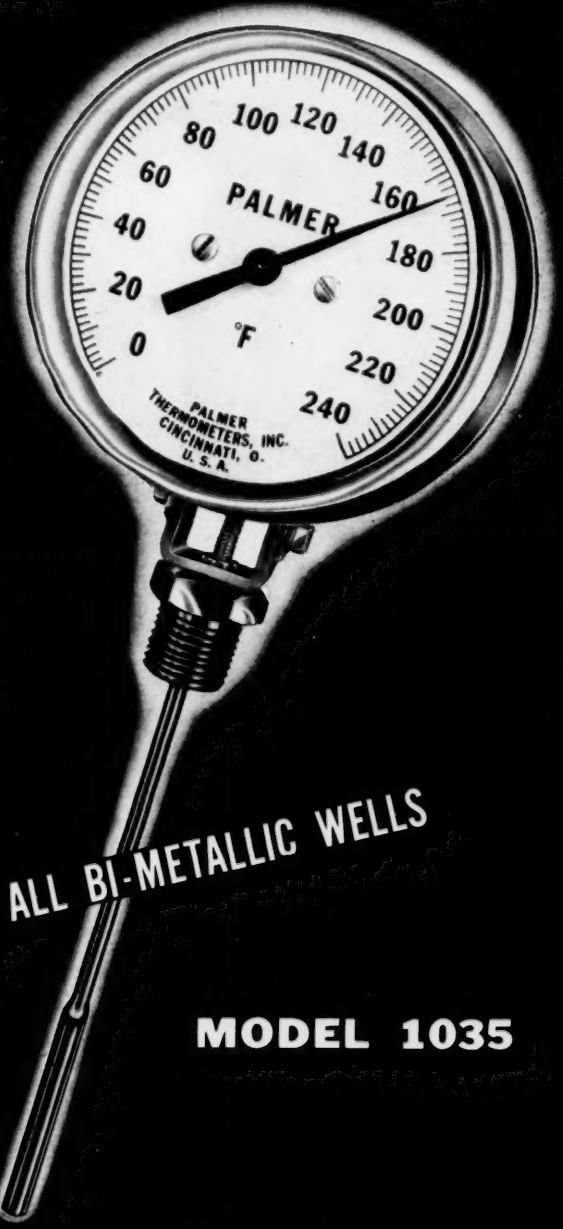
SINCE 1880

For more information circle **46** on inquiry card.

Outstanding Accuracy

PALMER

DIAL THERMOMETER

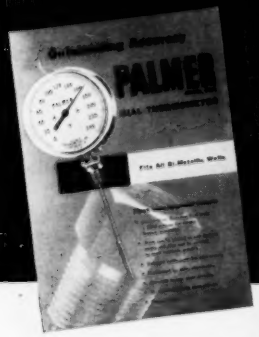


Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

FITS ALL BI-METALLIC WELLS

MODEL 1035



Write for Free Bulletin 1035 for complete description and prices.

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **47** on inquiry card.

CASE YOUR PRODUCT . . . PROTECT YOUR SALE

G & K style-tanned case leathers are both decorative and protective. These luxurious leathers add merchandising appeal to your products and protect delicate instruments against damage.

Wherever *your* customer carries *your* product, the mark of quality is evidenced by a tailored leather case. G & K will design and fabricate cases in any shape or size . . . offer unlimited color styling in addition.

For protection, safety and beauty . . . specify G & K . . . the world's largest manufacturer of industrial leather products.

GRATON AND KNIGHT

GRATON & KNIGHT *Company* INC.

WORCESTER, MASSACHUSETTS

Mechanical instruments for

TEMPERATURE

PRESSURE

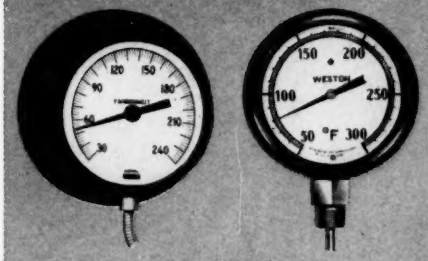
VACUUM

HUMIDITY

LIQUID LEVEL

PNEUMATIC RECEIVING

INDICATING



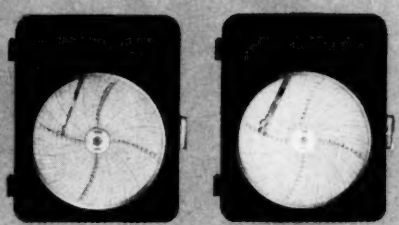
BIMETAL THERMOMETERS

Exclusive multiple helix bimetal elements. Exceptional rigidity and fast, dependable thermal response. Available in straight and angle forms . . . head dias. from 2" to 5" . . . ranges from −100 F to high as +1000 F . . . stainless steel stems from 2½" to 24".

FILLED SYSTEM THERMOMETERS

Liquid-, vapor-, gas-, or mercury-filled. Dial-indicating. Fixed stem or distant reading types. Accurate compensations. With or without electric contact feature.

RECORDING



TEMPERATURE AND/OR PRESSURE . . . HUMIDITY . . . PNEUMATIC RECEIVING

1 to 4 pens. Multi-pen instruments allow each pen the full range of the chart — or limit each pen to its own zone — as desired. Each system operates independently. Safety links prevent damage when moving elements exceed established ranges. Precalibrated systems need be checked at only one point. Standard zoned charts available for instruments combining two different types of data.

Weston supplies

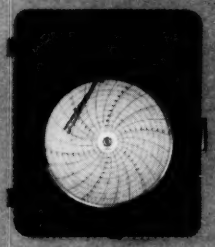
Looking for the right mechanical instrument? No need to compromise in any particular! You'll find *exactly* what you need within the complete WESTON line . . . one that will fill your requirements efficiently, and most economically. And you'll get the advanced design, rugged construction, and the dependability that have kept Weston the leader in precise instrumentation for close to three quarters of a century. For complete information on any of these mechanical instruments, contact the Weston representative in your vicinity, or write, Weston Electrical Instrument Corp., 617 Frelinghuysen Avenue, Newark 5, N. J.

For more information circle **49** on inquiry card.

ALL PNEUMATIC CONTROL FORMS

NON-INDICATING CONTROLLERS . . .
temperature or pressure

Pneumatic controllers of the "High Sensitivity" type with approximately a 5% throttling range. The air relay is a simple trouble-free ball-valve type operated directly from the measuring element. Can incorporate electrically driven cams to provide time cycle control.

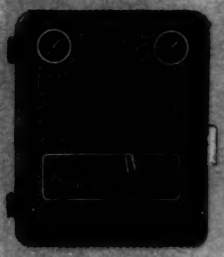


RECORDING CONTROLLERS . . .
temperature or pressure
pneumatic receiving
temperature-humidity

Narrow and full range throttling, automatic reset and quick response control forms.

PROGRAM RECORDING CONTROLLERS . . .
temperature or pressure

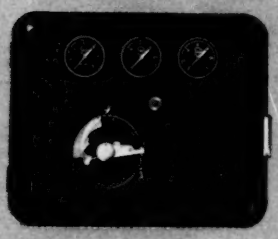
Variable control according to predetermined time schedule, as established by contour of cam mounted on chart.



INDICATING CONTROLLERS . . .
temperature or pressure

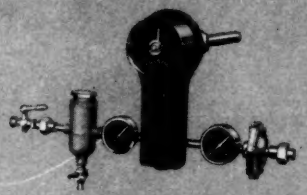
Single, duplex, and double system models. Full-range control settings; all control forms. Standard temperature ranges up to 800°F. Pressure ranges up to 7500 psi or 150 mm of mercury vacuum.

liquid level — Bubbler-type elements.



TIME CONTROLLERS . . .
temperature or pressure

Standard instrument which can be adjusted to provide different rates of rise, and durations of the hold period. Holding temperature or pressure can be changed to any point within the range of the instrument.

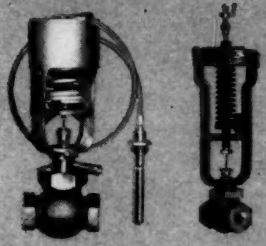


'FAULTLESS' CONTROLLER
. . . temperature

Apparatus-mounted. Suitable for operation between—40° and 700°F. Dependable expansion-stem type. Operates on 18 psi air supply. Direct and reverse acting types.

'SIMPLEX' CONTROLLER
. . . pressure

Apparatus-mounted, or used remotely. Pressure is transmitted to controller, which positions the air valve, regulating pressure to the top of the diaphragm valve. Operates on 18 psi air supply.



SELF-OPERATING CONTROLLERS . . .
temperature or pressure

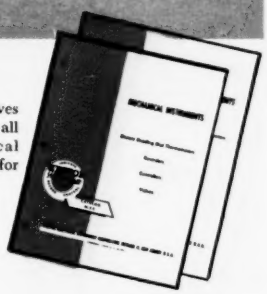
Self-contained instruments requiring neither compressed air nor electricity; employing only the power developed within their own systems. Valve sizes ½" to 2". All required ranges.

DIAPHRAGM MOTOR VALVES

Valves for all kinds of control systems. Direct, reverse acting, and three-way types.

them all

Catalog M-2-C gives complete data on all Weston Mechanical Instruments. Write for copy to-day.

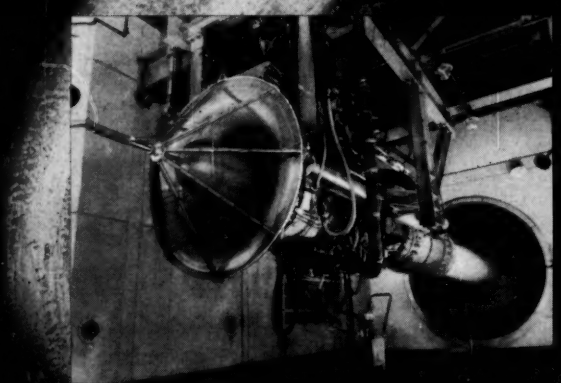


WESTON *Instruments*

A DAYSTROM UNIT

For more information circle **49** on inquiry card.

BISHOP TUBING



Photograph of J57 Engine undergoing test. Courtesy, Ford Motor Co., Aircraft Engine Division

is used by Ford Motor Company's Aircraft Engine Division

Aircraft, rocket and missile manufacturers are today concerned with greater endurance and finer performance of their aircraft assemblies and parts.

Bishop Tubing meets these rigid requirements against corrosion, high temperatures, resistance to oxidation, vibration, stress and shock so that most aircraft manufacturers are today using *Bishop Tubing* as set forth in the ASM, ASTM, MIL-T and AN-WW-T specifications.

You, too, can specify Bishop Tubing on your next order.

Manufacturers of: Seamless and Welded and Drawn Stainless Steel Tubing (.008" to 1" OD), Mechanical, Capillary, Hypodermic and Aircraft Grade. Nickel and Nickel Alloy Tubing (up to .625" OD) Tubular Fabricated Parts, Glass-to-Metal Sealing Alloys, Clad Metals & Composite Wires, Platinum Group Metals and Chemicals. **Catalogs on Request**

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Malvern, Pennsylvania Malvern 3100

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SR-4® LOAD CELLS OFFER YOU NEW ACCURACY—EASE—ECONOMY IN ALL INDUSTRIAL WEIGHING AND PROCESSING

Baldwin SR-4 Load Cells end the costly task of moving loads to and from a weighing unit. Now weigh right in process! Compact Baldwin transducers will measure any tension or compression force—shaft or jet engine thrust—cable tension; determine center of gravity, weight and balance. The applications are virtually unlimited. Weigh loads at rest or in motion. Measurements are accurate to better than ±1/4%; repeatability is better than ±1/10%.

Standard Baldwin SR-4 Load Cells range in capacity from 50 to 200,000 lb. The varying electrical signal from the SR-4 Bonded Wire Strain Gage, basic component of the load cell, can be fed to a wide variety of Baldwin recording or computing equipment.

Whatever your weighing problem, a B-L-H representative can help you. For more information, write today for your free copy of Bulletin 4301 on SR-4 Load Cells.

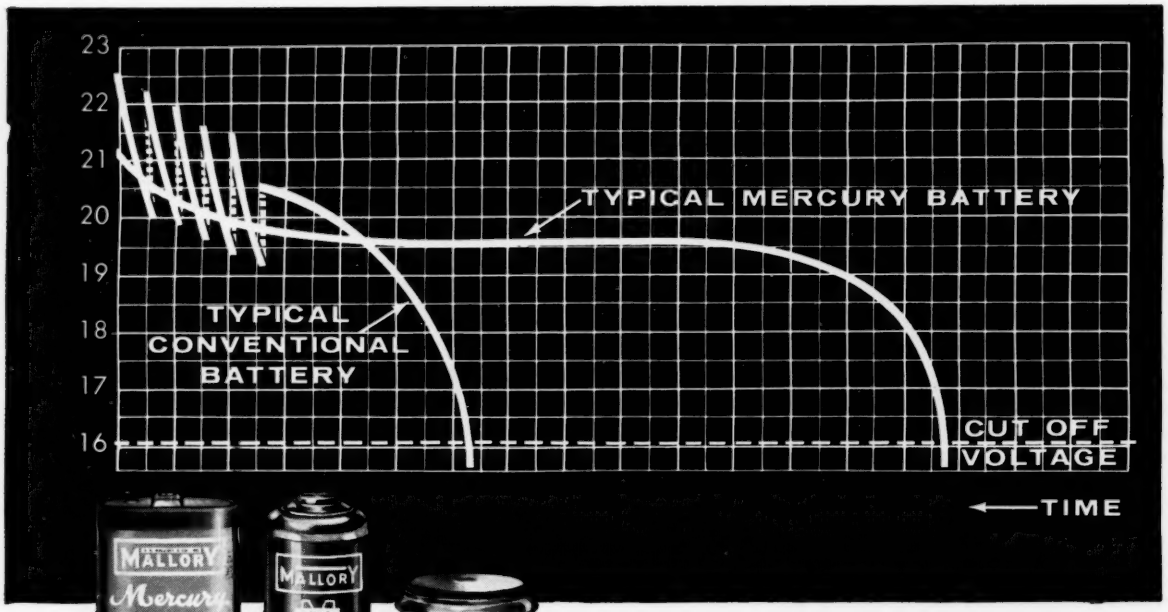
BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle **51** on inquiry card.



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Designing dry cell powered products . . . transistor radios, "cordless" clocks, alarm systems, portable instruments.

Give them new values in performance, convenience and miniaturization, by designing around Mallory Mercury Batteries. This unique energy source, pioneered and perfected by Mallory, offers you properties never before possible.

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Miniature size . . . a lot of energy in a little space . . . has made it possible to shrink the size of equipment with self contained power to new standards of compactness.

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Expect more . . . get more from

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MALLORY
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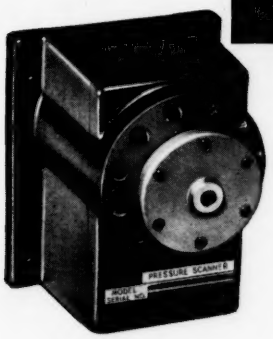
For more information circle **52** on inquiry card.

Multiple Pressures with **ONE TRANSDUCER**

the New DATEX PRESSURE SCANNER*



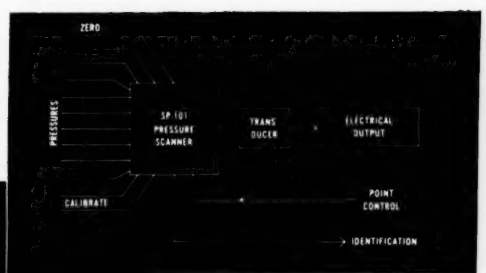
MODEL SP-101
PRICE **$395.00**

Designed to pneumatically switch a number of pressure sources into a single output port, the SP-101 Pressure Scanner introduces entirely new concepts into the field of pressure instrumentation. By providing an economical means of measuring a multitude of pressures, this device will accelerate the growth of automatic pressure recording in fields where it was heretofore economically unfeasible. Additionally, the pressure scanner not only reduces the number of transducers required for multiple pressure measurement but can be used to increase accuracy of measurement with presently available components. This is done by automatically introducing calibration and/or zero pressures during each recording cycle, permitting calculation of exact transducer response; and thus enabling greater measurement accuracy. Also, since the transducer is vented to atmosphere between pressure ports, hysteresis effects are minimized, contributing to greater measurement accuracy.

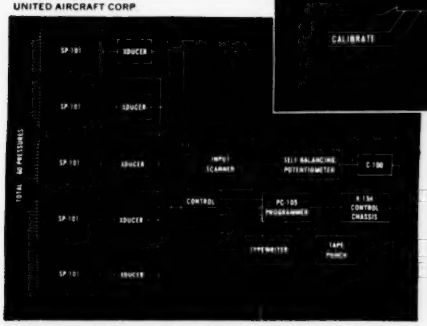
Basically, the SP-101 consists of a stator having 12 input ports, and a rotor that connects any one of the twelve input ports to an output port. The rotor is rotated to a desired position by a unidirectional high-torque motor, whose operation is controlled by means of a positive positioning arrangement. A relay circuit is incorporated in the unit to provide dynamic braking in order to stop the motor in a position where the rotor and stator ports are in coincidence.

The SP-101 Pressure Scanner can be used in applications that require the measurement of 12 pressures, all within the same transducer range. The unit can be externally programmed to switch pressures in any sequence desired, or it can be operated by means of a manual switch to select pressures to be measured.

TYPICAL SYSTEM USING ONE TRANSDUCER



*MANUFACTURED UNDER LICENSE FROM UNITED AIRCRAFT CORP



Typical Datex Digital Data Recording System for Recording 60 Pressures

SPECIFICATIONS

FLUIDS:
Air and non-corrosive dry gases

PRESSURES:
From 0.1 psia to 350 psig

POWER:
50 watts, 115V a-c, 60 cycle

CONNECTIONS:
Input and Output–⅛"NPT

POSITIONS: 12

Designed for bulkhead mounting.

For additional detailed information, write for Bulletin SP-101-1.

GIANNINI DATEX DIVISION

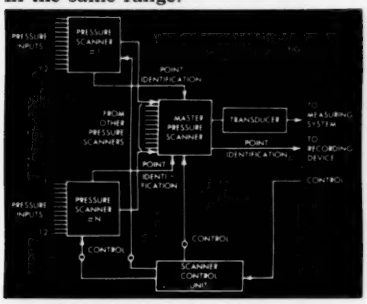
1307 South Myrtle Avenue, Monrovia, California

G. M. GIANNINI & CO., INC. 918 EAST GREEN STREET • PASADENA, CALIFORNIA

For more information circle **53** on inquiry card.

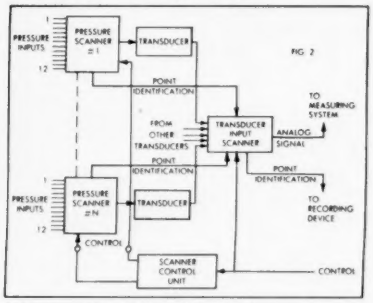
APPLICATION NOTES:

BY USING ONE pressure scanner to interrogate twelve other pressure scanners, as many as 144 pressures can be measured with only one transducer. A block diagram of a typical system is shown in Fig. 1. The 144 pressure inputs are connected to twelve pressure scanners. One output for each of these scanners will be connected to the input ports of an additional pressure scanner. The output of the latter scanner will thus sequentially scan the inputs of the 144 pressure variables. The aforementioned system is generally applicable where all pressures fall within the same range.

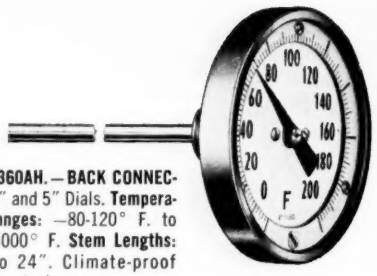


IN NUMEROUS APPLICATIONS, such as in engine test and wind tunnel operation, pressures vary over a wide range during the course of a recording cycle. With conventional multi-pressure recording systems, considerable measurement errors often result when the pressure drops to a small percentage of full scale.

IN ORDER TO ACHIEVE greater accuracy of measurement, the overall range is broken up into a plurality of smaller ranges. The SP-101 in combination with other Datex components can be used in an arrangement allowing the value of the pressure to be determined prior to measurement: permitting the appropriate pressure range to be selected so the optimum measurement accuracy can be provided.



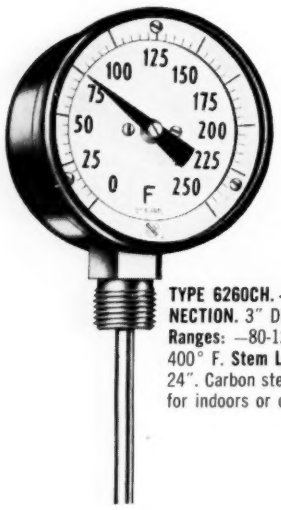
WHERE A PLURALITY of transducer ranges are required, the input pressures are connected to the pressure scanner associated with the range which will offer greatest accuracy. This system is illustrated in Fig. 2. An increase in overall system speed is possible over that of the single transducer operation. As an example; assume a system containing ten pressure scanners that will be controlled in two groups of five each. While the transducers associated with the second group are being scanned, the first group is positioned to the next point. In this manner, the pressures of group number one are being stabilized while the transducers of group two are being recorded.



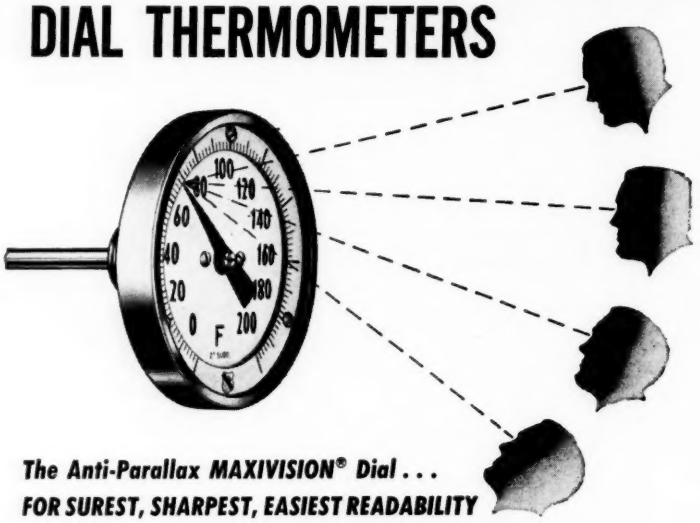
TYPE 6360AH.—BACK CONNECTION. 3" and 5" Dials. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 2½" to 24". Climate-proof stainless steel case.

GET ACCURATE "ON-THE-SPOT" TEMPERATURE READINGS...

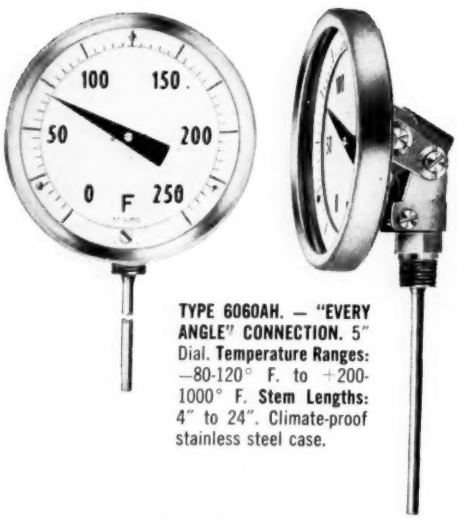
INSTALL 'AMERICAN' BI-METAL DIAL THERMOMETERS



TYPE 6260CH.—BOTTOM CONNECTION. 3" Dial. **Temperature Ranges:** —80-120° F. to +50-400° F. **Stem Lengths:** 2½" to 24". Carbon steel case suitable for indoors or outdoors.



The Anti-Parallax MAXIVISION® Dial . . .
FOR SUREST, SHARPEST, EASIEST READABILITY
. . . Is Available Only In 'American' Thermometers



TYPE 6060AH. — "EVERY ANGLE" CONNECTION. 5" Dial. **Temperature Ranges:** —80-120° F. to +200-1000° F. **Stem Lengths:** 4" to 24". Climate-proof stainless steel case.

Nowadays fewer men are required in power and processing plants to inspect operations, so it is more important than ever to have observation points handy for them. 'American' Bi-Metal Dial Thermometers, installed at important check points, eliminate frequent trips to the control house. Inspectors can observe variations in process temperatures "on the spot" and take steps to effect corrections.

The economy of these thermometers goes far beyond the time-saving convenience of local indoor and outdoor readings. Their accuracy and utility contribute to lower costs. They provide the greatest sensitivity in bi-metal actuation. The low-mass single helix bi-metal coil is precisely centered in the stem to assure quick, accurate response to all temperature changes — to prevent the retard effect the coil can cause if rubbed against the stem wall.

The Maxivision dial is a split-level dial with pointer set on the same plane as the outside raised ring that carries the graduations. No perspective effect, no parallax! Readings are sure, sharp and accurate at a glance!

The availability of 'American' Bi-Metal Dial Thermometers in types with back, bottom or "Every Angle" connection permits selection to fit the conditions of each location. For example, the "Every Angle" type can be set at any point within 180° on two axes. Thus it is particularly recommended for installation above or below eye level or in close quarters where the types with fixed back or bottom connection would be impractical.

PHONE YOUR INDUSTRIAL SUPPLY DISTRIBUTOR for assistance in selecting the types of 'American Bi-Metal Dial Thermometer best suited to your needs. He can provide separable sockets in al materials and sizes normally required.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

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For more information circle **54** on inquiry card.

Bill Erickson discusses MAGNETIC TAPE RECORDING

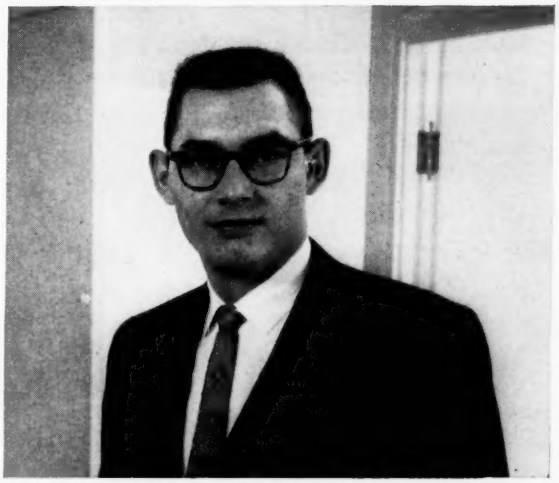
Most phenomena that can be depicted electrically can be recorded on magnetic tape. Long-known but relatively recently perfected, magnetic tape recording has won wide acceptance as a particularly valuable tool in data-handling and process control applications. The very nature and versatility of this tool, however, require the most mature judgment in its use, lest unwarranted enthusiasm lead to misapplications and incorrect results.

In the field of industrial control, magnetic tape recording has been used most effectively for the storage of electrical analog information in such processes as conveyor control for article sorting, machine tool and pattern control, dry and liquid food batch mixing, and so forth. In data-handling problems, it has served the engineer in speeding analyses of complex physical phenomena. In communications experiments, multi-channel tape units have provided the scientist with simulation of otherwise physically unrealizeable filters. In all these instances, the merit of magnetic tape recording lies in its ability to store electrical analog information and make it available for play-back, or re-run, as often as may be necessary.

Of the few methods available to "advance" or "retard" time, none is as practical as the use of magnetic tape. For instance, it is frequently overlooked that a tape recording can be considered as a variable delay line of considerable equivalent electrical length. Merely by varying the play-back speed, or the relative position of the reproduce heads, or both, one line (or tape) can be used to delay a number of signals relative to each other, one signal relative to a number of others, or to some external source.

Despite this versatility there are definite limits of usefulness within which the application of tape recording should be confined. Such a limit is typified in the problem of signal "dropout." By this is meant the distortion, or even complete loss, of a signal caused by the presence of minute nodules in the tape itself. The occurrence of such imperfections is completely random and can be controlled only during production of the tape. And while significant progress has been made in recent years to improve the quality of tape, ultimate perfection has not yet been achieved.

In data-handling and process control fields, the use of magnetic tape recording is particularly well-suited to digital techniques where large quantities of information can be stored most economically in a minimum amount of space. In all applications where high-speed random access is not required, magnetic tape recording provides a relatively inexpensive and wholly suitable solution to the recurring information storage problem. Here signal dropout is virtually eliminated because the electrical impulses are of a pulse present-pulse omission presentation and are recorded at, or very near, the tape saturation level.



Wilbur Erickson, systems engineer, specializing in input-output equipment, discusses magnetic tape recording.

The use of magnetic tape recording is, at one and the same time, the prerogative and the responsibility of the systems engineer. His experience and ability to make intelligent use of this one of the many tools available to him, will define his stature as a systems man. The potential of magnetic tape recording in systems has barely been scratched, but the applications to which it can, and undoubtedly will, be put are as limitless as man's imagination to devise them.

By applying the latest proven techniques, our well-qualified staff at Daystrom Systems is prepared to take single responsibility of assembling and installing a system to meet your needs. We are currently compiling a file of new applications and papers on various parts of systems, both industrial and military. If you are interested in receiving the file and periodic additions, please write us.

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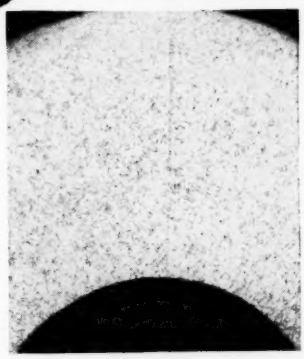
Super-Pressure Tubing—Economical and Dependable for pressures as high as 100,000 PSI

Here's how *you* can take the high cost out of high-pressure installations. No more machining and deep-drilling of stainless steel bar—that's old fashioned and expensive. For high-pressure autoclaves and in research labs where pilot equipment for hydrogenation and polymerization processes require high pressures, Superior super-pressure tubing is cutting high costs, helping avoid critical failures and downtime.

Superior super-pressure tubing offers long service life, high fatigue strength, excellent corrosion and chemical resistance. Available in single wall or composite wall (shown above), it is designed to carry internal pressures ranging from 15,000 to 100,000 psi, in OD sizes ranging from .125 in. to .750 in. Primary advantages of single wall tubing are economy and reliable service, plus long life, at recommended maximum working pressure for a given size. Composite wall tubing, used for extra-high pressures, offers the advantages of combining different materials. For example, the inner wall can be highly corrosion resistant, while the outer wall, not exposed to such corrosion, can be of a more economical material. Analyses for Superior super-pressure tubing include stainless steel Types 304, 316, 321 and 347 and AISI 4130 alloy steel.

Why not call on our long practical experience with super-pressure tubing. We can help you with virtually any tubing problem that confronts you. For more super-pressure tubing information, get your free copy of Data Memo 22. Write Superior Tube Company, 1968 Germantown Avenue, Norristown, Pa.



Unretouched photomicrograph shows etched section of Type 304 stainless steel super-pressure tubing at a magnification of 50x. Note smooth, uniform ID and fine grain structure.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010" to ⅝" OD—certain analyses in light walls up to 2⅛" OD

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For more information circle **56** on inquiry card.

Biographies of significance

SIGNIFICANCE

ONE OF today's pioneers in the field of automation, particularly process control, is Dr. Donald P. Eckman, Professor of Instrumentation Engineering, Mechanical Engineering Department, Case Institute of Technology. He is the author of *Principles of Industrial Process Control*, one of the first definitive texts on the subject, published in 1945. He followed with a second book, *Industrial Instrumentation*, published in 1950, and later wrote the "Industrial Instrumentation" Section of Kent's *Mechanical Engineering Handbook*. In addition, approximately 30 technical papers have appeared under his name. His particular interest in analysis and development in pneumatic and hydraulic control, electrical servomechanisms, advanced system process control and nonlinear control behavior has made Dr. Eckman one of the foremost leaders in our field, and we are happy to acknowledge his important contributions to it. Views of Instrument Laboratory work at CIT are shown on page 1501 of this issue.

DR. DONALD P. ECKMAN

A NATIVE of Hillsdale, Michigan, Professor Donald P. Eckman graduated from Jackson High School in 1932 and from Jackson Junior College in 1934. He received his Bachelor of Science Degree in Mechanical Engineering from the University of Michigan in 1938, and his Master's Degree from Michigan a year later.

His first job launched his instrument career—he became a Development Engineer for Brown Instruments Division of Minneapolis-Honeywell Regulator Co., where he stayed for seven years. During this time he came up with some new developments for the Minneapolis-Honeywell line of products and obtained several patents.

In 1945 John Wiley & Sons published Dr. Eckman's first book on process control, a book whose quality established him as an authority in automation at the relatively tender age of 31.

These first successes whetted Dr. Eckman's appetite for advanced study. His yen for teaching, writing, and more scientific work in the field of automation led him to Cornell University, where he joined the staff in 1946 as a teaching fellow.

At Cornell he instructed classes in engineering, mechanics and mathematics. While teaching, he also furthered his work towards his Doctor of Philosophy Degree which he received in 1950. While participating in this full schedule of teaching and research, Dr. Eckman found a few moments flitting by unattended. He promptly put them to use and had his second book published, also in 1950.

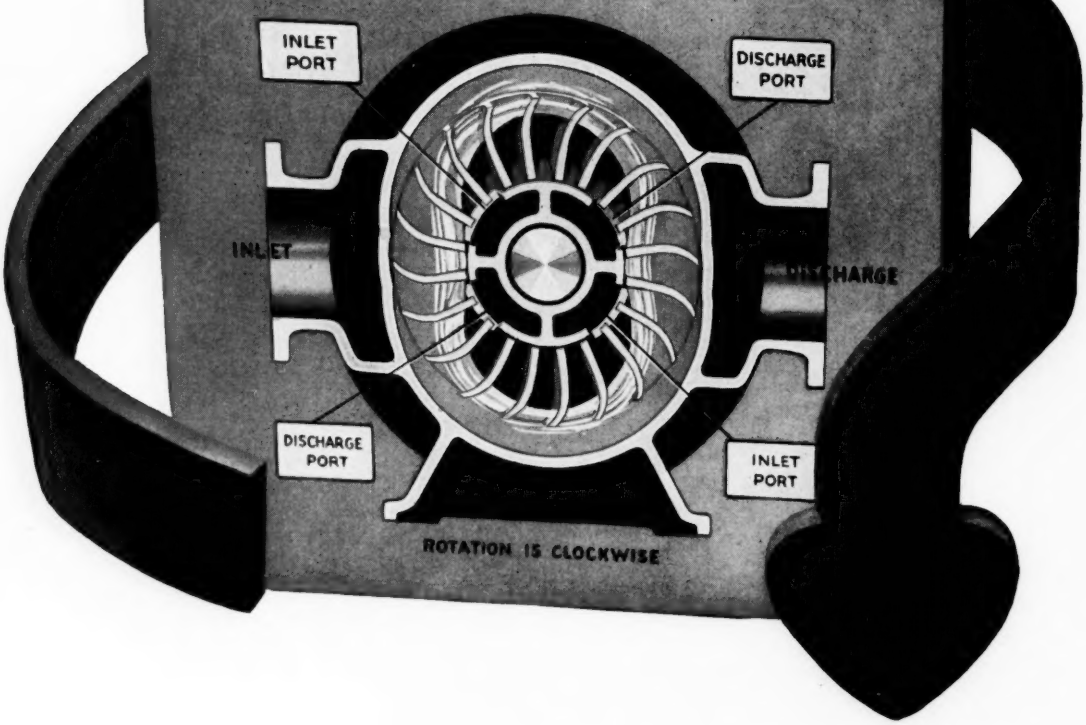
By this time, Don and wife, Jeanette, decreed it was time for a vacation. They hopped on a plane for Europe and, once there, mounted a pair of bicycles for an energetic tour through the Scandinavian countries.

In 1950, Dr. Eckman joined the staff at Case as an Assistant Professor. He advanced rapidly, becoming an Associate Professor in 1952 and full professor in 1955. During his career his experience has been sought for consulting by such outstanding enterprises as Conoflow Corporation, Oak Ridge National Laboratory, Swartwout Company, Leeds and Northrup Company, Thompson Products, Inc., and Warner and Swasey Company.

Dr. Eckman is a member of the Tau Beta Pi, Kappa Phi and Sigma Xi Honorary Fraternities. He also holds memberships in the American society of Mechanical Engineers and the American Society of Engineering Education.

Don and Jeannette live in Cleveland Heights with their five youngsters—Martha, Louise, David, Richard and Mark.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



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You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
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No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

The Wild, Blue, Yonder—Panhandle Pete

Twinkle, twinkle, little star,
How I wonder what you are.
Up above the world so far —
So I shot a rocket in the air,
It fell to earth I know now where.
We lose more damned rockets this way.
But who cares? We mak'em.

W. I. Klapsaddle

HAVE you avid readers of the technical press been following the doings of various rocket builders and what the products of their imagination can do? Have you ever desired to light off your own little space traveller? In the old days one could always purchase an extra supply of these things around the 4th of July but now, well, we're getting civilized—we cannot kill and maim with fireworks anymore(???).

So you want to fire one off in the cool of the evening? So you can't buy a skyrocket for love or money? So it is against the law? Well, here is where the Wallace Electronic Service Company of New Somerset, Jefferson County, Ohio, enters the picture. WESCO! has diversified itself from the designing and building of gas analyzers, Par-Kometers and Filters to a brand new product—Himmelrakets. Yes, WESCO! has just affiliated itself with the noted Rocket firm of Die Vereinige Deutsche Himmelraket und Schüssgebangen Gesellschaft, A. G. of Ohbiehellendam, Holland, the birthplace of our illustrious Director of Research (and Champion Hog-Caller) Dr. O. U. Alles.

In the words of our genial Salesmanager, Waldo I. Klapsaddle, Jr. who says, "Listen Cuz, WESCO! aims to please, and about this here time of year people want to get lit-up and blow their top and these here Himm, duh, skyrak, er, whatever the hell them there things are my brother-in-law Elmer Flannelgurdle is making out in back . . ."

"But Mr. Klapsaddle, I thought Elmer and his wife Penelope were canning ramps out in the back of the factory?" I asked.

"Sure, Cuz, they are, and ain't the smell awful? But he's building these here others things too." So we went out to look: Mr. Andy Francy, Flight Engineer of WESCO! gladly posed with the latest model of Flannelgurdle's Himmelraket, as you can see in the photo. Andy is holding the Model FH-4 Himmelraket in his left hand, and in his right hand he holds the Goosey Gander Honker, Model M1A1 Amphibious Combination Burglar Alarm and Christmas Dinner (self-powered and fail-safe too).

As you can see in the photo, the Himmelraket is a four-stage, semi-unguided free-body model with a quadruple-threat-activated head (laughing gas, itch powder, crabgrass seed and a notice from the Bureau of Internal Revenue to "Gather up your old checks and come see us!") and a built-in five-and-a-half-stage impedance-coupled amplifier. You can see the two vacuum tubes near the top of the missile. The remaining half-stage amplifier is cunningly hidden away in the fuselage, along with an M.G. set, synchronous converter, computer, air-conditioning unit, and a combination T.V. Bar and lounge.

As Elmer described it over a glass of ramp juice, "Ah think we have something the public (that's the guvermint) wants. Our Model F.H. 4 Himmelraket is the result of concentrated thinking on the part of our entire organization. Take a look at the well-designed propellant chambers with our patented vectorized, velocimetric exhaust ports. Notice too the wedge-shaped entering adits of these chambers. Ah used to lie awake at night thinking about them until I figured out a way to simulate Dixie cups—I used Dixie cups! The fuselage was developed through use of our Model Low I.Q. Komputer and

Which one of these Genisco centrifuges meets your requirements for testing components under simulated operational G-loadings?

. . . as required by Mil 5272A, procedure II

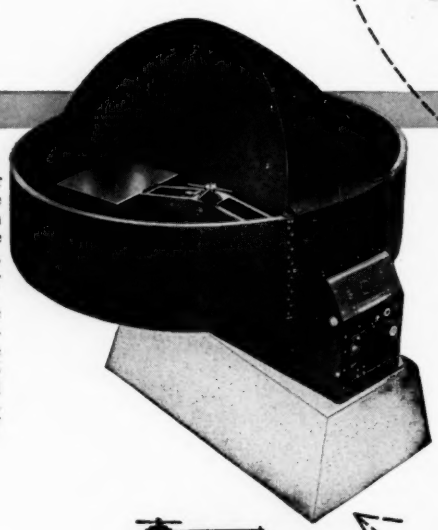
Genisco G-Accelerators provide a quick, precise means of testing components in an acceleration environment similar to that encountered in actual operation.

They are extremely accurate machines, easy to operate and built to withstand years of hard use.

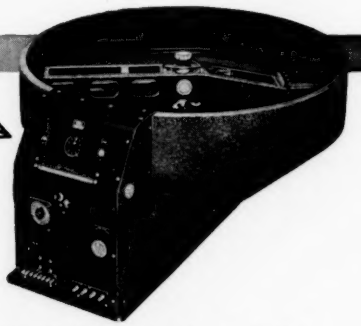
These features particularly suit them for large volume testing programs, as well as for precise laboratory prototype development.

More than 100 Genisco G-Accelerators of various capacities are now in use throughout the world.

Complete technical information on all models and accessories is available. Please direct your inquiry to: Contracts Manager, Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California.



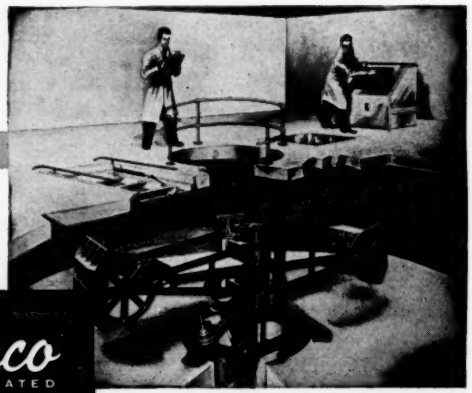
MODEL C159 The larger capacity of this machine permits whole system components and complete packages to be tested. Two objects, each weighing 100 pounds and 24" x 24" x 18" in size, can be accommodated simultaneously. G-range of the machine is 0.024 G to 75 G's. Maximum centrifugal capacity is 2000 G-pounds. Nominal radius of gyration 48".



MODEL B78 Used primarily for testing relays, switches, tubes, motors, valves, and other small components, and to calibrate and evaluate accelerometers. Accommodates objects weighing up to 25 lbs.; has G-range of 0.017 G to 120 G's. Maximum centrifugal capacity is 1200 G-pounds. Nominal radius of gyration 24".

MODEL D184 A high-speed machine, designed to test accelerometers and other instruments under acceleration forces from 1 to 850 G's. Full centrifugal capacity is 1000 G-pounds. Nominal radius of gyration 12".

MODEL E185 This newest and largest Genisco centrifuge was recently built for the U.S. Air Force. Two mechanical or electronic packages, each weighing up to 300 pounds, can be subjected to an acceleration environment of up to 65 G's simultaneously. Nominal radius of gyration of the machine is six feet. An automatic dynamic balancing system automatically compensates for any excessive unbalance in the machine during test runs.



ACCESSORIES ADD TO OPERATING EASE A number of accessories including a strobe system, air system, optical system, tub cover, access doorway, and slip ring systems, designed to give greater operating convenience, are available for Genisco G-Accelerators, Models B78 and C159.

Modifications in any basic machine or accessories to meet your particular requirements will be carefully considered.

Genisco INCORPORATED

RELIABILITY FIRST

For more information circle **58** on inquiry card.

Panhandle Pete—Cont.

the results checked in one of the local wind tunnels (on the B&O RR). The ratio of the integrated area of the entering surfaces to the cube root of the leaving surfaces was derived from the Law of Inverse Vacuums, discovered by I. Diedpoor and Ura Lier in 1902."

"Well sure, but what about guiding this thing and how do you launch it and what's it good for except to scare the birds?" I broke in.

"Ah shucks, we don't try to guide our rakets. All these here other companies are guiding theirs and where are they? Ours is the only raket on the market which is guaranteed to go where you least expect it. No other company can make this claim, so we expect a lot of sales."

"How are your sales," I counters, wondering if I can get a little stock while the price is still cheap.

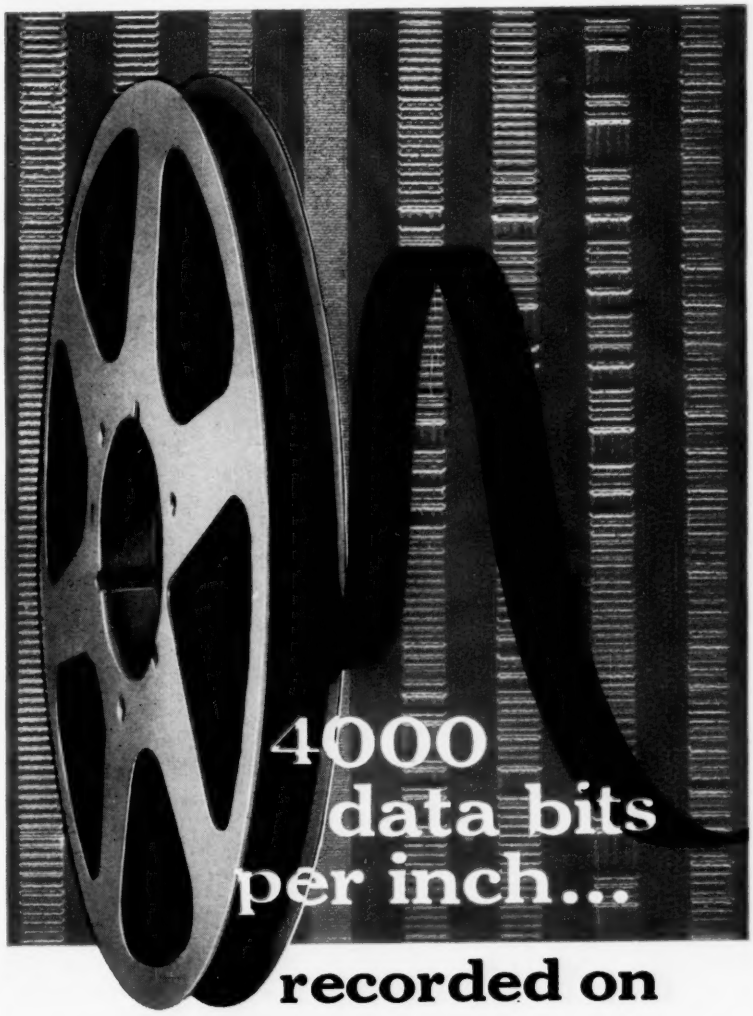
"We are having a little trouble selling these rakets to the guvermint because of the stupidity of a few purchasing agents who really don't know how expensive these electronic gadgets must be."

"For example, see the AM/FM/PM Radar Reflector mounted on top of the F.H.4? One guvermint man said that was jist a ten-cent funnel. Well, we showed him our costs for developing this funn . . . er, reflector, and it came out exactly to $376,487.21 including 21 cents for the funn . . . er, reflector, $487.21 for instrumentation, and $376,000 for personnel recruitment."

"As to launching our product, WESCO! developed a portable launching platform you can see in the picture. This cost $157,324.56. Now that guvermint man had the nerve to say that that was a lot of money for a 6-foot piece of rainspout. But we showed this naive fellow that (1) this is cheap for anything that will add to our country's defense, (2) the rainspout . . . er launcher, costs only $4.56, but (3) you just don't go around using these here missiles without complete systems analysis, and the cheapest launcher analyst we found cost us $157,320.00. So that $157,324.56 we are charging the guvermint is a no-profit patriotic price that will have to go up unless he orders his rakets right away."

"Yes sir, that fellow knew a good thing when he saw it, he ordered two gross right then and there. Now we need about 242 engineers to fill this order. If you know of any, drop us a line." *Panhandle Pete*

Microphotograph of pulse recording on Soundcraft Instrumentation Tape



recorded on

SOUNDCRAFT type "A" INSTRUMENTATION TAPE

and played back without error!

In the new Rocketdyne IDIOT* II computer system, 4000 data bits (over 500 bits of information per channel, per linear inch) have been stored in an inch of Soundcraft Type "A" Instrumentation Tape . . . double the amount of information that has been stored in equivalent lengths of competitive tapes! What made the difference? Soundcraft Type "A" Tape . . . the only tape engineered specifically for pulse recording. Its special RCCH oxide formulation provides an extremely hard surface with high thermal softening point – prevents imbedding of foreign particles. The formulation is uniformly applied to the durable Mylar† base by patented Uni-level process; then Micropolished to remove surface irregularities. These exclusive design features assure you of error-free pulse recording with Soundcraft Type "A" Instrumentation Tape. Write for Soundcraft Type "A" Instrumentation Tape Brochure.

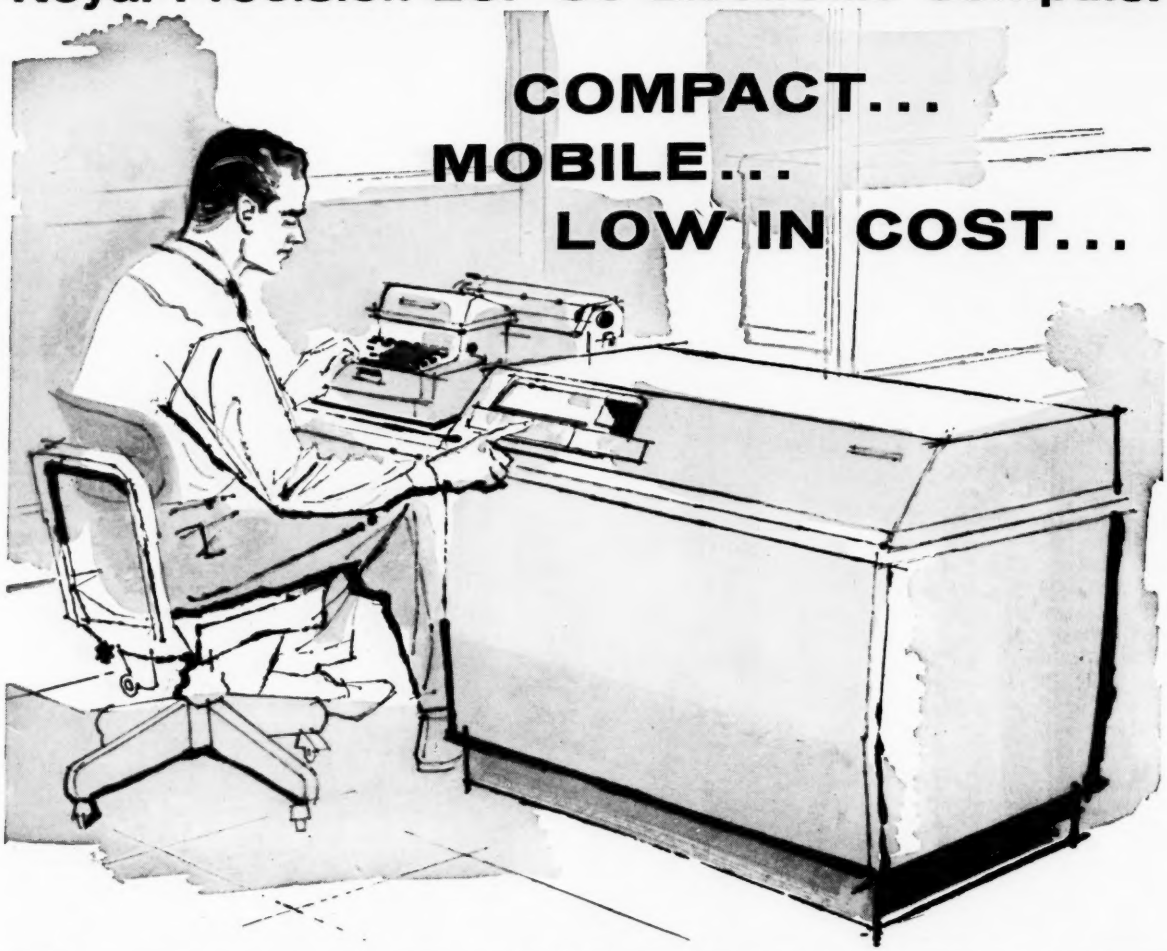
*Rocketdyne Instrumentation Digital On-Line Transcriber. †Dupont T. M.

REEVES SOUNDCRAFT CORP.

10 E. 52nd St., N. Y. 22 • West Coast: 338 N. La Brea, L. A. 36, Calif.

For more information circle **57** on inquiry card.

Royal Precision LGP-30 Electronic Computer



high-speed computation right at your desk

The result of 20 years' experience in the design of electronic computers, LGP-30 puts you in complete control of your own engineering problems. Used right at your desk, LGP-30 allows you to program your own material without planning in detail. You modify equations on the spot, follow your work to completion. Thus, you eliminate much detailed calculation . . . uncover added time for creative engineering.

Ease of operation. LGP-30's simple command structure offers the same complete internal programming found in computers many times its size and cost. Internally binary, serial, single address . . . LGP-30 enters and reports alpha-numeric information by punched paper tape or keyboard.

Greatest capacity in price range. The most powerful stored program computer of its size yet developed, LGP-30 has a magnetic drum "memory" of 4096 words. Fully automatic, it performs sub-routines . . . executes self-modifying programs.

Exceptional flexibility. LGP-30's wide range of applications includes double precision abstractions; compiling and diagnostic routines; 3-address interpretive routine with floating point abstractions; matrix operations including inverting and Eigen value problems; basic trigonometry and log functions; square root and roots of polynomials.

Nation-wide sales and service. Detailed analysis of your requirements is available through Royal McBee's nation-wide staff of trained applications engineers.

Outstanding features of LGP-30

- **Operates from regular wall outlet (110 volts AC).**
- **No expensive installation . . . no external air conditioning.**
- **Unusually large "memory"— 4096 words.**
- **Word length: 32 bits, including sign and spacer bit.**
- **Average access time: 8.5 ms.**
- **Optimum access time: 2 ms.**
- **Lowest cost ever for a "complete" computer.**
- **Nation-wide sales and service.**

For further information, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE CORPORATION

ROYAL TYPEWRITERS • McBEE BUSINESS SYSTEMS

See the LGP-30 in operation, Booth 527, ISA Show

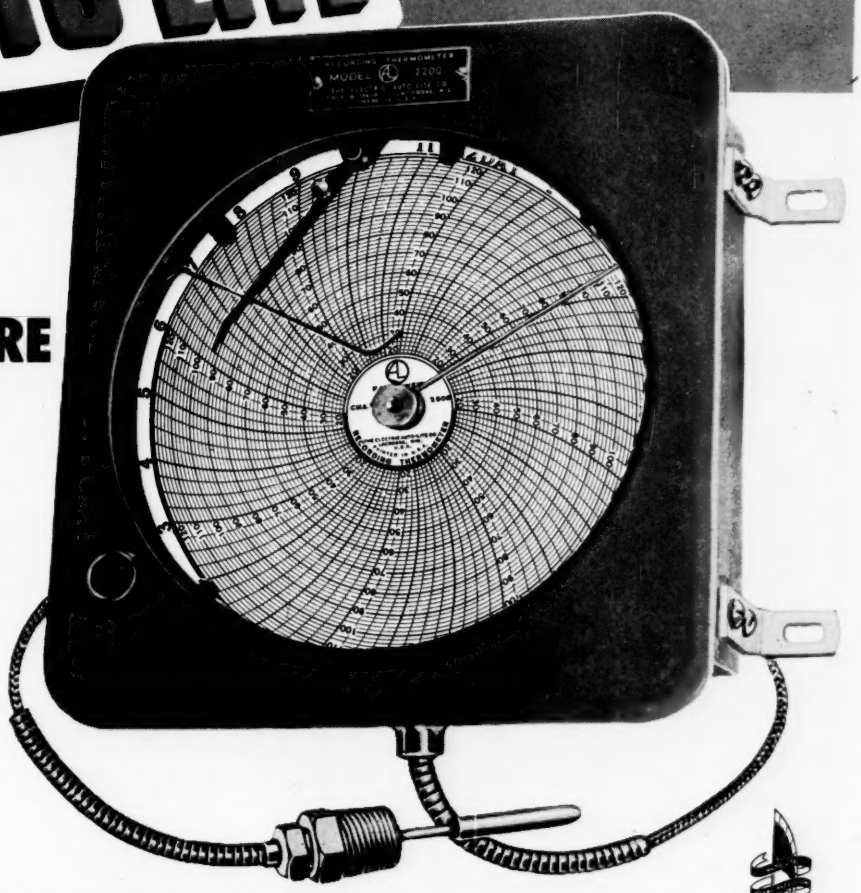
For more information circle **219** on inquiry card.

Instrument-Automation Exhibition
Booth 514 . . . A NEW development from

AUTO-LITE

INKLESS TEMPERATURE RECORDER!

The newest advance in temperature recording . . . Auto-Lite model 2200 operates completely without ink. It simplifies temperature recording for most processing operations.



- 2 small mercury batteries in case energize transistor oscillator connected to stylus arm.
- Stylus records temperature on 6" evenly calibrated sensitized chart.
- Battery life approximates 3000 hours.
- Records operating temperatures for 24-hour or 7-day cycles.
- Easily serviced — minimum maintenance.

Electric or mechanical chart drive available for either 24-hr. or 7-day rotation. In wall mounting, portable and self-contained type cases. Remote reading with capillary tubing. Temperature charts in ranges from −40°F to +550°F. Write for further information.

See the Auto-Lite display of indicating and recording thermometers . . . at Booth 514, ISA Instrument Exhibition, Cleveland.

THE ELECTRIC AUTO-LITE COMPANY
INDUSTRIAL THERMOMETER DIVISION
TOLEDO 1, OHIO
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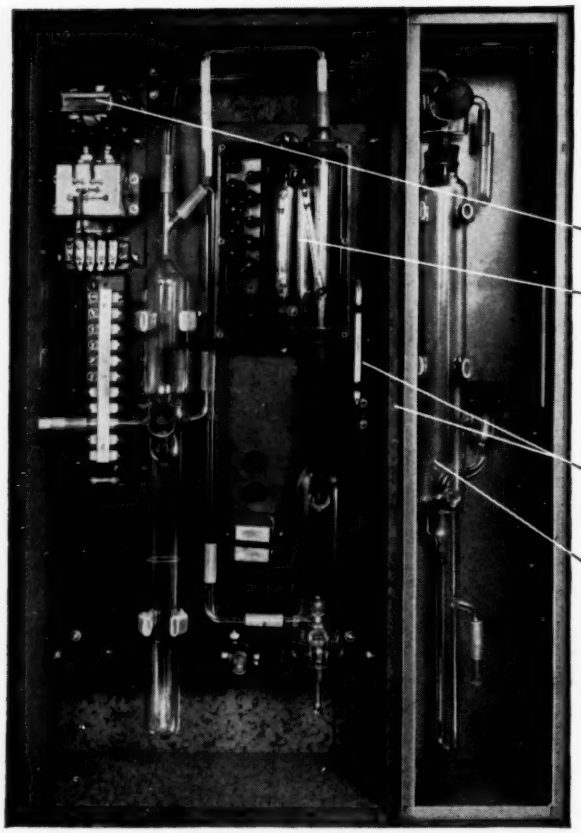
For more information circle **60** on inquiry card.

Gas Analysis a problem?

SOLVE IT PERMANENTLY WITH EQUIPMENT WHICH GIVES YOU THESE 7 ADVANTAGES



Thermal Conductivity Analyzer

In hundreds of plants, L&N's Thermal Conductivity Gas Analyzers are solving the problem of obtaining accurate, reproducible measurements of CO_2, SO_2, H_2 in N_2 and many other gases. Because they embody the benefits of thirty years' experience in process gas analysis applications, L&N Thermal Conductivity Analyzers . . . . .

1. Eliminate gas measurement upsets. A constant voltage regulator excludes a-c power variations.

2. Provide accurate measurements by using the unique L&N cell design which gives you vibration-free operation due to a rigid filament support . . . electrical stability by using a platinum filament . . . high corrosion resistance due to glass coating of the filament . . . and immunity to small flow variations because the cell is designed to utilize the gas diffusion principle.

3. Make reproducible measurements possible. Ambient temperature swings are eliminated by enclosing cell assemblies in an insulated case with thermostatically-controlled temperature.

4. Permit low maintenance and therefore minimum downtime as a result of the time-tested analyzer design including features such as flexible junctions, heavy glass construction, etc. Coal and asbestos filters remove mist and dust to assure cleanliness of the analyzer system.

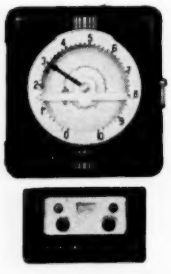
5. Match the inherent accuracy and sensitivity of null-balance Speedomax®G and H Recorders.

6. Permit selection of the particular type of control forms to fit the process. These include electric control, electro-pneumatic, and all-pneumatic controls—each designed to work with the Analyzer-Recorder system for maximum throughput.

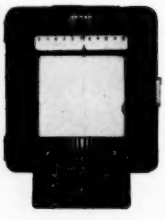
7. Gives you undivided responsibility. The entire thermal conductivity system . . . sampling system, analyzer, recorder-controller . . . is designed, engineered and built by one organization with a nation-wide sales and service staff.

These "plus" features of L&N's Thermal Conductivity Gas Analyzers can help satisfy your demands for top quality products which lead to substantial savings. An eight-page booklet, Folder ND46-91(6) giving data on this equipment, is available by writing to Leeds & Northrup Company, 4955 Stenton Avenue, Phila. 44, Pa.

Speedomax H Series 60 Electric Control



Speedomax G Series 60 Electro-Pneumatic Control



Speedomax G Pneumatic Controller

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INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

Editorial

Needed: Better Program Management!

EVERY conference on the subject of "automation" has one or two speakers with something of value to say. Our sympathies are extended to these lonely and patient men who must of necessity listen to hours of superficial drivel while awaiting their turn at the coveted microphone, and whose valuable contributions are of necessity buried in thick and expensive "proceedings" of the conference. Our sympathies also extend to the reader, seeking to learn something new from yet another set of papers on automation, patiently reading thousands of words in an attempt to find some new thoughts or ideas. Perhaps many readers of these proceedings have concluded, as did your editors, that the millions of words in these scores of proceedings are simply endless variations of a few simple ideas, namely:

1. Automation means automatic control.
2. Automation includes data handlers, servos and computers.
3. All industries now have some applications suitable for automation.
4. The automation device usually does a specific job faster and more efficiently than its manual predecessor.
5. The automation industry began with the Watt fly-ball governor (or the Babbage calculator) and is now growing.
6. Unemployment is undesirable and anti-social.

But let us not decry the ingenuity required to expand these few simple ideas into hour-long dissertations and hundred-page books, and then to repeat the process again and again with ever-more subtle variations of the central theme. The proceedings of automation conferences are tributes to the limitless imagination and ingenuity of the technical man turned speaker.

The proceedings of these conferences may have yet other significance. A contribution to posterity may await the analysis of how many ways it is possible to say the same thing, or perhaps an analysis of the technique for making a simple idea appear profound and complicated. The proceedings of the many automation conferences now on file are recommended to students interested in research in these provocative fields.

A new dimension has been added to this situation with the growing number of international conferences on automation and cybernetics. The authorities in our field have tux and will travel anywhere, cheap. A distinguishing feature of these international conferences is the ease with which translations can be made; they may be the only conferences on record that can be read without knowledge of the language.

Mechanization vs Automation

THE DEBATE that still rages on the subject of the definition of automation often resolves itself into a discussion of the difference between mechanization and automation. The definition proposed by your editor in 1954 (Automation: the use of devices—mechanical, pneumatic hydraulic, electrical and electronic—to perform automation decisions and efforts) should resolve this particular point. Mechanization is obviously the use of mechanical automation devices, usually with hydraulic or pneumatic elements in the system. It is but one part of the entire field of automation. Automation is the term for the horizontal field of automatic control—encompassing the more specific fields of mechanization, computation, and instrumentation, which terms apply to

EDITORIAL—CONTINUED

specific and cohesive phases of the general field of automation.

Although this will arouse the ire of those who wish automation to mean only mechanization, or only computation, or only instrumentation, let us admit that all of these latter fields are specialties, with specialized personnel and problems and societies. "Mechanization" men belong to the ASME; "computation" men belong to the Association for Computing Machinery or the Simulation or DDA Councils; "instrument" men belong to the ISA.

The terms "automation" and "automatic control," standing alone, are non-specific and ambiguous in that they could apply to more than one or two recognized fields of endeavor. The term "control engineering" is a bit more specific in that it applies to the theoretical design considerations underlying all closed-loop servomechanisms—thereby excluding the vast field of instrumental measurements.

In matters of definition, man proposes but the public disposes. For several years the terms "automation," "automatic control," "control engineering," "instrumentation," and "mechanization," have been used with great abandon by writers and speakers. Despite the many proposed and contradictory definitions for each, review of much of the literature of the field seems to say that the following definitions are what most people "mean" when talking about:

AUTOMATION—the use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for performing automatic decisions and efforts.

AUTOMATIC CONTROL—same as automation.

CONTROL ENGINEERING—the theoretical and design considerations underlying closed-loop servomechanisms.

INSTRUMENTATION—the art and science of measurement, but including process control considerations.

MECHANIZATION—the use of mechanical techniques for performing automatic efforts, usually with pneumatic or hydraulic elements.

MHA

HELP!

SOME of us are concerned over the terrific dilution of information affecting the state of the computer art.

Computers are glamor gadgets and everybody wants to get into the act. Therefore nearly all technical meetings and technical publications have papers and articles on computers, to say nothing of the overlap in technical societies.

In spite of the terrific progress being made in our field, the plain fact is that there isn't enough really worthwhile material to go around. Furthermore, busy people (and if you're not busy in this field you won't be in it long) do not have time to attend all the meetings and read all the articles to weed out what is worthwhile.

What to do??

In an attempt to find out, Dr. W. J. Schart (Convair-San Diego) invited representatives of the IRE—PGEC, the AIEE—CCD, the Association for Computing Machinery, the Joint Computer Conference, the Simulation Council, and the Digital Differential Analyzer Council to discuss the matter.

As a result E. L. Harder (AIEE)*, H. W. Nordyke (IRE), Stanley Rogers (DDA), R. R. Favreau (Simulation Council), R. Hamming (ACM), J. R. Werner (JCC) and Bill Schart met in New York City on 12 June. The tone of the meeting indicated recognition of the problem and a desire to cooperate. Some positive suggestions were offered but must be cleared with the representatives' parent organizations if any progress is to be made.

Stan Rogers (Convair-San Diego) has suggested that all worthwhile contributions to the state of the computer art be collected and reprinted under one cover, perhaps with the *Simulation Council Newsletter*.

An excellent idea! But many a treatise which, taken alone, seems to be a real contribution, is 100% plagiarized*. Some speakers give the same talks (sometimes thinly disguised by slight changes) at several meetings, and these are picked up and published in several media.

Conversely other work, which might seem repetitious, may involve a subtle difference, or the germ of an idea, which will constitute real progress. To do a perfect job of culling such material would require a genius (or better)—full time (or more)!

However, something less than a perfect job could be a great improvement over the present situation. So perhaps we could get along with something less than a genius. But it would still require cooperation from others concerned to get permission to reprint.

Any other ideas? *JHM*

*Mr. Harder said that notices of 51 computer meetings had crossed his desk since the first of the year!

*However, we do not agree with Dr. Simon Ramo, who said that speakers at technical symposia reminded him of a bunch of anemics giving each other blood transfusions. Giving one's knowledge does not weaken the donor.

"PYROMETEERS"

Pyrometer Engineers—Buyers—Plant Executives attending the ISA Show

We invite you to INDUSTRIAL PYROMETER AND SUPPLY CO. ALTON ILL. U.S.A. *...our* BIG PARTY

Avery Hack

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STATLER HOTEL

Grand Ball Room

Frank Hack

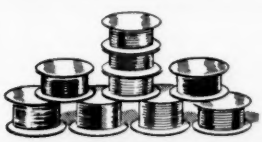
2 BIG NIGHTS: Tues., Sept. 10 and Thurs., Sept. 12, 9:00 p. m. till?

★ See Our Gigantic Floor Show. ★ Big Bar, All the Finest Liquors You Can Drink.
★ Big Buffet Supper—All the Turkey, Ham and Fine Foods You Can Eat.
★ Big Orchestra—Dancing ★ Beautiful Girls—Side Attractions.

Your Carricature by artist Lenn Redman in folder as a Souvenir.

NOTE: Although we engaged the largest ballroom in Cleveland's finest hotel and while we would like to have all our guests attend both nights as we have always done in the past, this may be impossible this year because of Cleveland's fire law limiting occupancy of ballroom. Therefore, when writing for invitations please advise which night you prefer, should we be unable to accommodate you both nights. Or, visit us at Booth 722 at Cleveland Auditorium for invitations possibly available for additional night.

SEE OUR BOOTH NUMBER 722, CLEVELAND AUDITORIUM

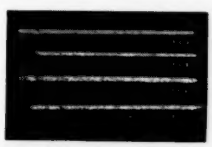


WIRES

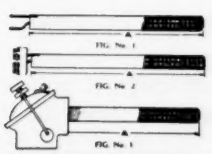
THERMOCOUPLE LEAD WIRES

INSULATORS

THERMOCOUPLE HEADS



TUBES



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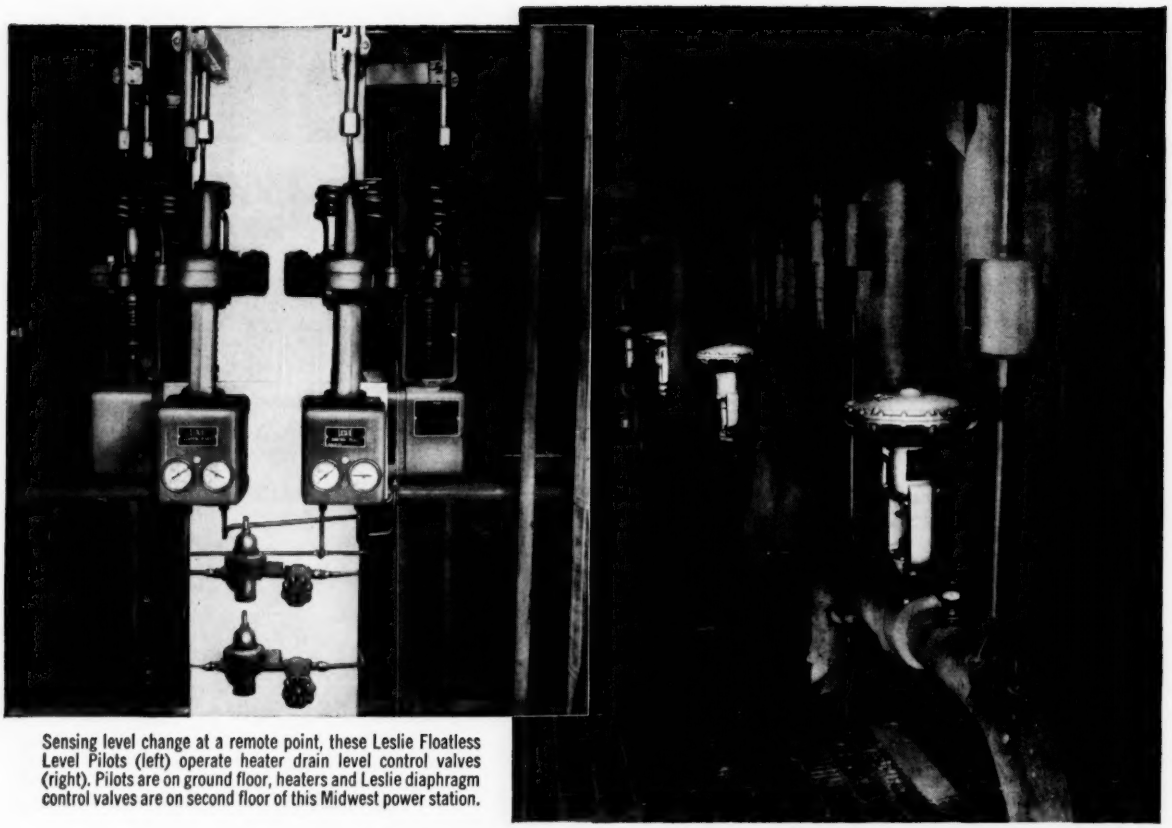

Sensing level change at a remote point, these Leslie Floatless Level Pilots (left) operate heater drain level control valves (right). Pilots are on ground floor, heaters and Leslie diaphragm control valves are on second floor of this Midwest power station.

differential pressure method offers

STABLE, FASTER-SENSING LEVEL CONTROL

Because the Leslie Level Control Pilot uses the differential method for sensing changes in liquid level, it receives its impulse changes faster than any other type of level control. You can install it *anywhere* below liquid level, mounted on the valve, or at a point remote from vessel or valve. Used on either open or pressurized vessels, it controls the level of virtually any liquid including water, gasoline, oil, alcohol, solvents, chemical solutions and acid.

And It's Floatless, too!

There are no floats, torque tubes, seals, stuffing boxes or thermal-hydraulic tubes which are affected by turbulence, wear or temperature changes. Installation is fast and uncomplicated. Simple spring adjustment changes set point. Maintenance free, rugged "high impact" design is unaffected by shock. The only *one* moving element is virtually frictionless . . . its total movement is only .006".

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A high air loading capacity in the Leslie Control Pilot means a fast response with a smooth, throttling action free from hunting or cycling.

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REGULATORS AND CONTROLLERS

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Temperature regulation generally is accomplished by controlling the flow of the heat-transfer medium. Thus, a temperature regulator is a control valve with a temperature-sensing device which either alters the position of the valve directly or works as a relay to apply external power or line pressure to the valve.

Temperature Regulators

C. S. BEARD General Controls Co.

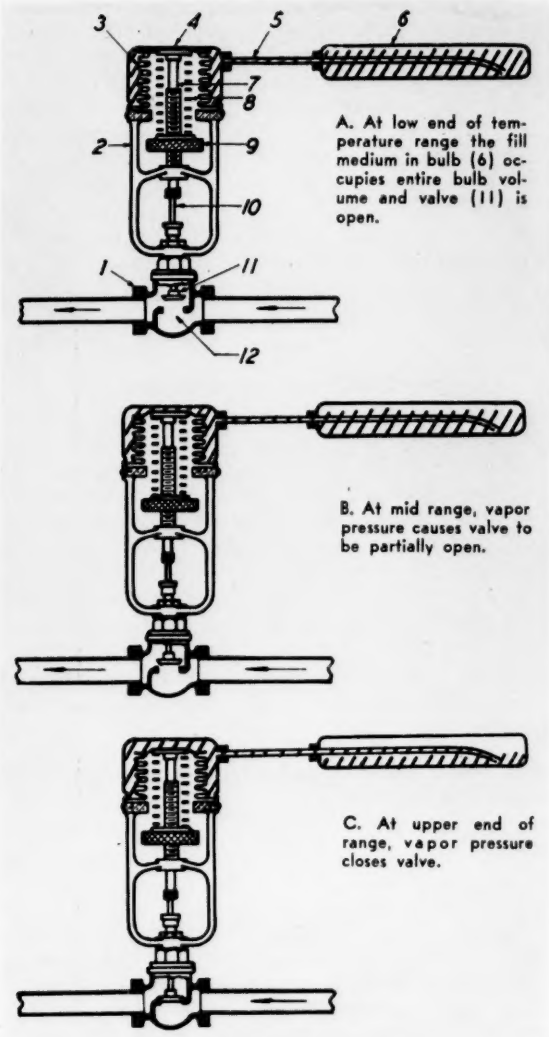
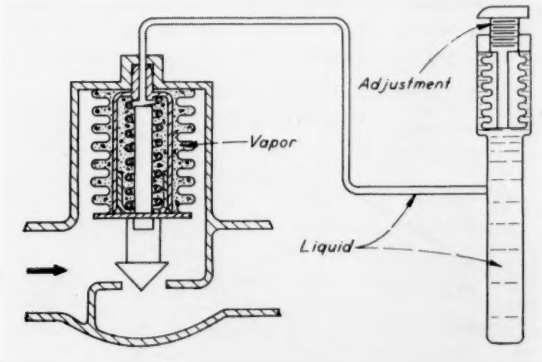


Fig. 4-1. Liquid in bulb vaporizes to establish pressure equilibrium between vapor and liquid phases. Vapor must be confined to bulb if valve position is to be proportional only to the vapor pressure.

Fig. 4-2. In hot-chamber-type regulators, expansion of liquid in sensing element forces liquid into bellows where it vaporizes because of steam in line and closes regulator.



TEMPERATURE regulators find almost as many applications as do pressure regulators. Radiator valves, gas or steam water-heaters, cooking kettles, hand presses, and many other pieces of equipment use temperature regulators to control the heat applied. Cooling applications also are widespread.

Thermal Systems

Any of the thermal systems used in filled-system industrial thermometers is suitable to operate a temperature regulator. The five thermal systems in general use are (1) vapor pressure, (2) liquid expansion, (3) mercury expansion, (4) gas expansion, and (5) metallic elements.

Although each of these systems can be used to operate a regulator, as will be described, there is an important difference between a thermal system designed to operate a regulator and one designed to measure a variable, *even though the principles are identical.* This difference is due to the fact that the instrument used to measure a variable is designed to have an accuracy of 1% or better over its entire range, which requires accurately calibrated springs, large-volume bulbs, etc. In contrast, the regulator is designed to regulate a temperature within 1F° to 3F° at any one temperature within its range, but should not be relied on to measure the temperature with accuracy over the entire range of operation. Regulators are

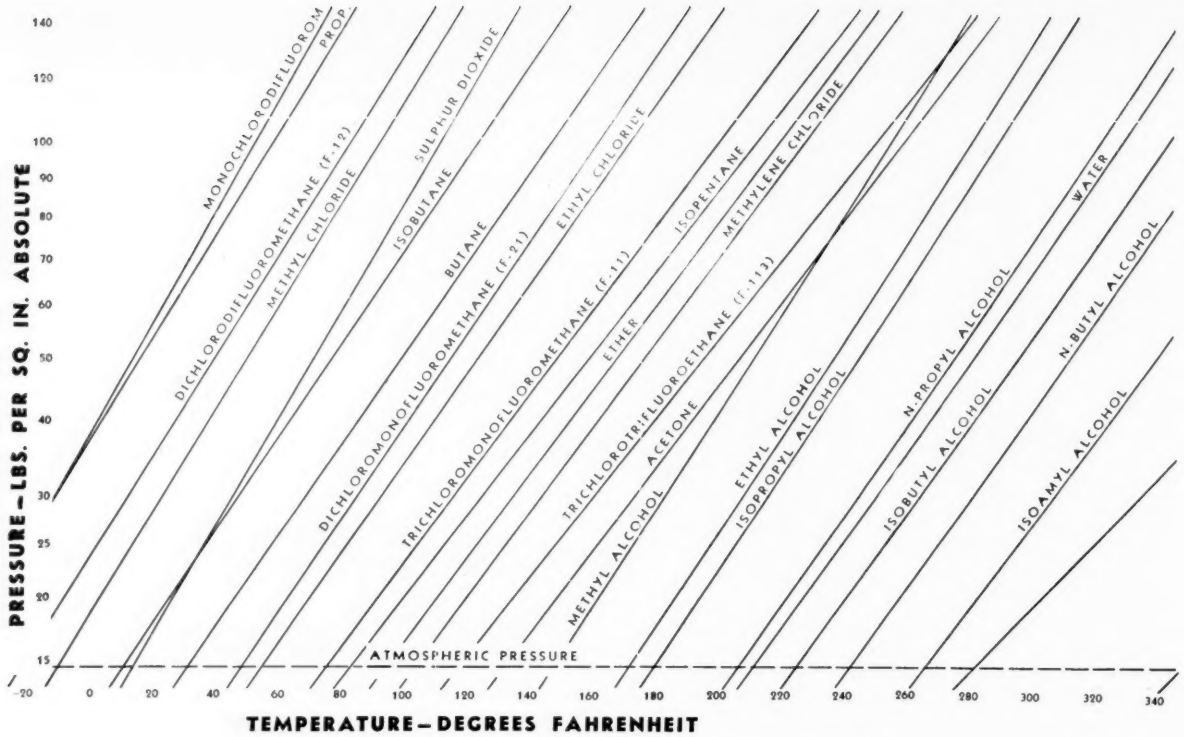


Fig. 4-3. Portion of chart of vapor-pressure vs temperature curves of filling media for vapor-pressure systems. Media are available for temperatures from below —100°F to above 750°F.

available with built-in dial indicators operating from the same sensitive element. The dial thermometer assists in adjusting the regulator and checking the temperature at the bulb—but for accuracy of measurement a calibrated thermometer should be used for the actual measurement of the variable.

Vapor Pressure

Vapor-pressure systems make use of the pressure exerted by volatile liquids when they vaporize. The pressure of the vapor-liquid phases varies with the temperature. Thus at some one temperature the vapor pressure will start to compress the bellows shown in Fig. 4-1, closing the valve. The point at which this action begins can be varied by changing the force exerted by the opposing spring (or weight in other types of regulators). The final position of the valve is that point at which the vapor pressure reaches equilibrium with the opposing spring (or weight).

The bulb must have sufficient volume of liquid that vapor never enters the capillary to the valve even under conditions of high temperature and large expansion of the bellows. As long as there is fluid in the bulb, the system is operated only by the *vapor pressure* of the filling fluid, as desired. If vapor were to enter the capillary tube for any reason, the valve position would be sensitive to the *expansion characteristics* of the vapor, which is an erratic factor.

Fig. 4-3 shows a portion of a chart giving the vapor-pressure *vs.* temperature relationship of liquids used as filling media in vapor-pressure systems. Many filling liquids are suitable in various ranges. Table 4-1 shows the most common filling media. Selection of medium depends on its thermal stability at the maximum operating temperature, handling conditions, etc.

Pressure of vapor is utilized in a different manner in the *hot-chamber-type* regulator used mainly in

Table 4-1. Ranges of Most Common Filling Media for Vapor-Pressure Systems, in Degrees Fahenheit.

ETHYL ALCOHOL	200	to	400
BENZINE	200	to	500
WATER	250	to	600
TOLUENE	250	to	500
ANILINE	400	to	700
ETHYL CHLORIDE	60	to	350
METHYL CHLORIDE	0	to	280
SULPHUR DIOXIDE	20	to	250
ETHER	100	to	300
PROPANE	–20	to	200
METHYL ETHER	–20	to	200
PROPYLENE	–40	to	190

steam applications (Fig. 4-2). Expansion of the volatile liquid in the sensing element (at right) forces a small portion of the liquid into the bellows chamber (at left). As the chamber is surrounded by steam, the liquid vaporizes, and the bellows expands and closes the valve. The valve opens when the sensitive bulb cools, permitting liquid to re-enter the bulb and reducing the vapor pressure. The temperature at which the regulator begins operating can be varied by changing the volume of the bulb by extending or contracting the displacement bellows shown in the bulb. The bulb must be lower than the valve.

Vapor-pressure systems predominate in temperature regulators.

Liquid and Mercury Expansion

Temperature regulators can be filled completely with liquid (Fig. 4-4) so that the inner valve is moved by *expansion of the liquid*. The familiar radiator thermostat is a common form of liquid-filled regulator; water is used as the liquid fill in the bellows so that its reaction parallels the pressure and temperature conditions of the steam system. Liquid mercury follows the same laws of expansion of liquids, except that it is vaporized at a higher temperature (680° F) than most of the other liquids.

A liquid-filled bellows which can be placed directly in the controlled fluid (Fig. 4-5) gives positive action. Designs of this type use either a removable bellows (for ease of replacement), or a corrosion-resistant well (Fig. 4-6) which is directly connected to the regulator. Installation of the sensing element in the controlled fluid, with piping brought to the valve, is not limited to any particular filled system.

The coefficient of expansion of mercury is low compared to other liquids used in temperature regulators. Mercury, therefore, is used mainly to actuate accurate electric switches or small pilot valves.

Gas-filled Systems

A *gas* which is non-condensible under operating conditions can be used also to actuate temperature regulators. The bulb volume must be large enough to minimize the effect of gas expansion in all parts of the system other than the sensitive element. However, the bulb volume is not as critical as in an indicating or recording instrument where the instrument actually measures the temperature, as has been mentioned. In temperature regulators the actual temperature usually is measured by an accurate thermometer in the controlled medium, and the compression of the regulator spring is changed to obtain the regulator action at the temperature indicated by the thermometer.

Differential Expansion of Metallic Elements

Relative expansion of two *metallic elements* is used to position a pilot valve in the design shown in Fig. 4-7. The sensitive element comprises two coaxial tubes; any difference in expansion of the inner tube as compared to the outer tube, or vice versa, results in a change in position of the pilot valve shown. The outer tube is usually the expanding element; the inner one being made of non-expanding material. The outer tube could be made of non-expanding material, but this de-

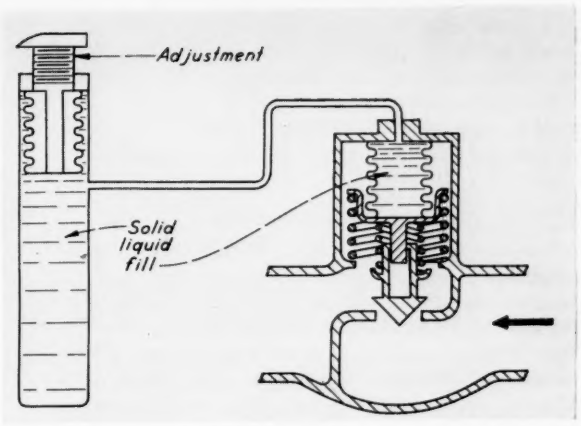


Fig. 4-4. In solid-filled systems bulb and bellows are filled with liquid. Pressure is exerted only by liquid expansion.

Fig. 4-6. ▶

Fig. 4-7 ▼

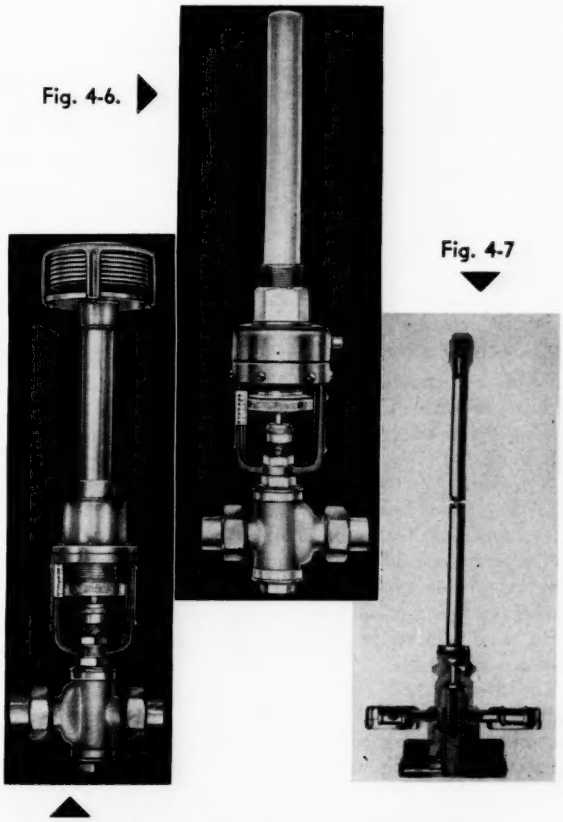


Fig. 4-5. Removable bellows head is placed on an extension long enough to penetrate insulation of vessel; thermal element is installed inside vessel being heated.

Fig. 4-6. This valve is directly connected to the sensing element which is protected by a thermowell.

Fig. 4-7. Difference in expansion of two metals causes pilot valve to open or close.

sign would slow down the response. The pilot valve shown in Fig. 4-7 is used to vary the pressure of an air source which operates a control valve.

The method of relative expansion does not adapt itself to direct operation of the regulator inner valve because the total motion is comparatively small.

Regulator Selection

Selection of vapor- or liquid-actuated temperature regulators is based on manufacturers' data. General practice allows use of a direct-operated single-seated regulator up to 2″ size with pressure drop of not more than 15 psi. A double-seated valve body makes it possible to use sizes to 6″ with a maximum pressure drop of about 35 psi. Use of a weight to balance the moving parts (Fig. 4-8) extends the range to 10-inch valves if the differential pressure does not exceed 15 psi. This type of valve finds successful application for low pressure-drops because the effect of unbalanced forces can be minimized by adjustment while the valve is in operation.

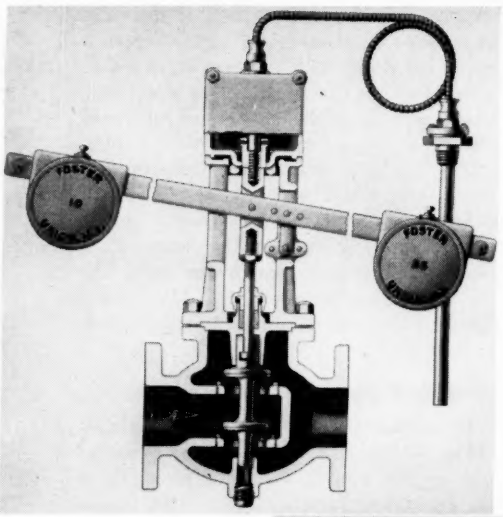


Fig. 4-8. Weight is used to balance moving parts so that thermal element is only required to upset this balance.

Pilot Operation

When an integral temperature-actuated *pilot* (Fig. 4-9) is used, line pressure can be used to position a single-seated balanced valve of at least 6″ size. The same approach, but using a diaphragm actuator rather than a piston, is used for low line pressures. The diaphragm, being larger than a piston in area, develops a greater total force, thus giving this valve greater sensitivity.

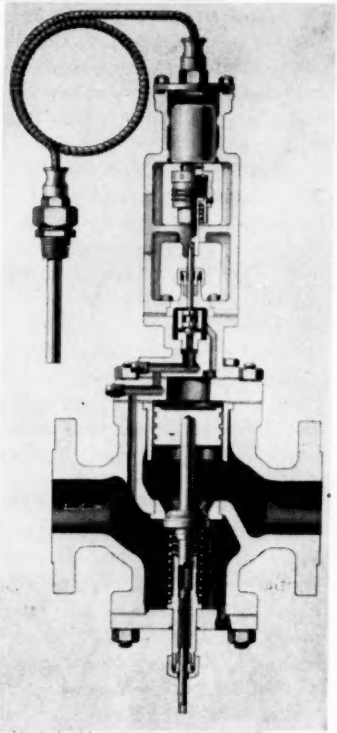


Fig. 4-9. Thermal element operates pilot admitting line pressure to position inner valve.

Combined Pressure-Temperature Control

When the temperature of a tank of oil, a heat exchanger, or some similar installation is controlled by varying the steam input, use of a regulator of any of the mentioned types does not control the steam *pressure* imposed on the equipment. During the period when the controlled liquid is being brought up to temperature, the regulator would open wide to furnish all the steam possible. This condition might place full line pressure on equipment which may have been designed for lower pressures. Two methods which supply a maximum steam rate while limiting the supply pressure are in use.

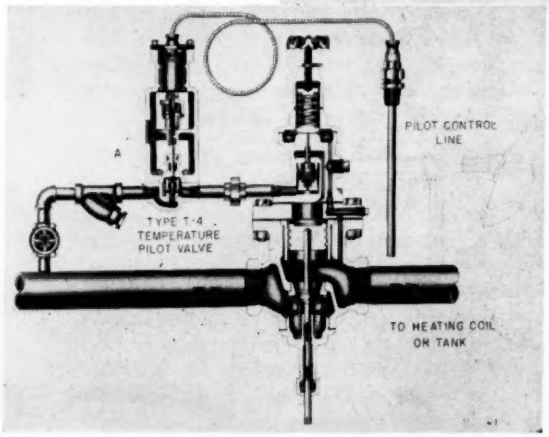


Fig. 4-10. Pressure control overrides thermal pilot to limit maximum pressure.

The first method (Fig. 4-10) uses a temperature control pilot in conjunction with an integral-pilot-controlled pressure regulator piped to a downstream connection. As long as the downstream pressure is below the set point, or insufficient to compress the spring in the pressure pilot, the small pilot in the pressure regulator remains open. Under these conditions the pressure which positions the inner valve by acting on its piston passes through the temperature pilot and depends on the temperature regulator. If the opening in the large control valve (as dictated by temperature requirements) allows the pressure to build up too much, the pressure pilot closes.

The second method (Fig. 4-11) uses a similar pressure-pilot approach to limit the steam pressure. The temperature-sensitive unit acts on a lever that extends into the pressure-sensitive element. The tem-

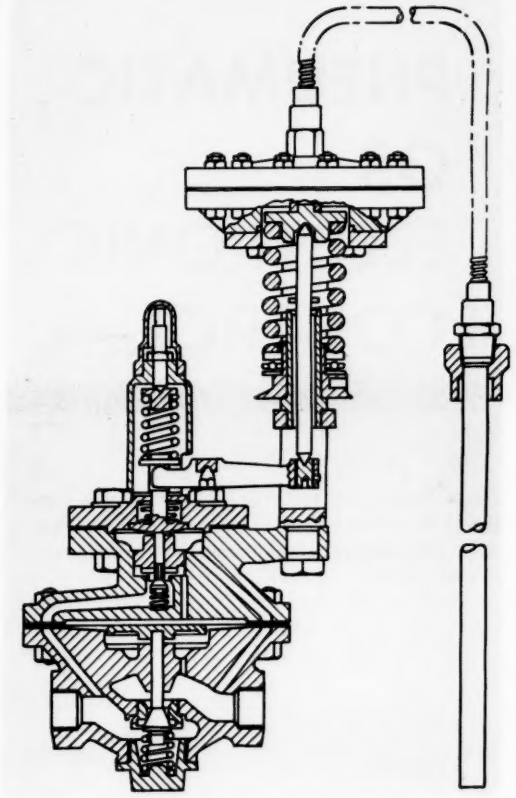


Fig. 4-11. Effect of pressure spring is decreased by thermal element to limit steam pressure, providing both pressure and temperature regulation.

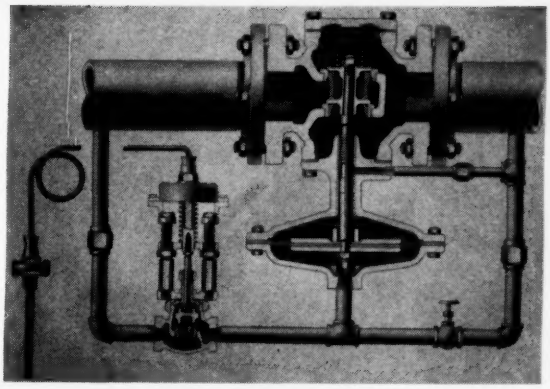


Fig. 4-12. Steam-control system. Thermal pilot introduces steam to condensate chamber in order to open control valve.

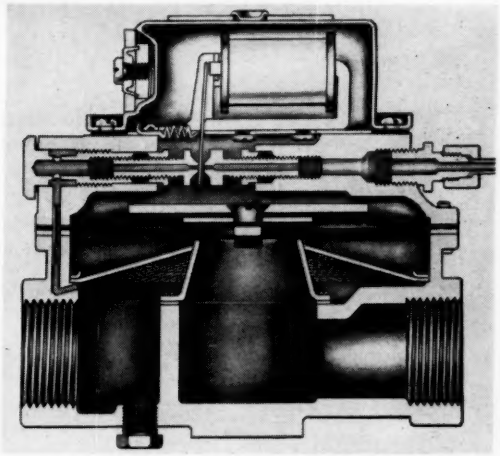
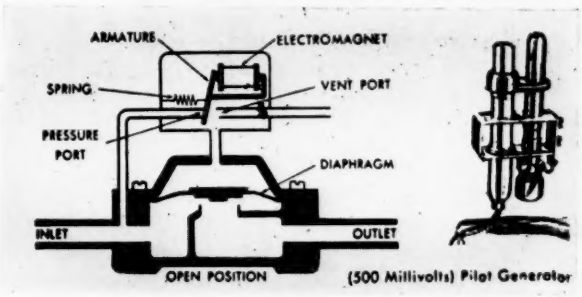


Fig 4-13. Thermocouple in gas pilot flame generates current supply for coil magnet in this pilot flame monitor.



perature is controlled by varying the effectiveness, or setting, of the pressure control spring. A temperature increase in the controlled liquid forces the diaphragm down to assist the pressure acting against the diaphragm of the pressure pilot, thus decreasing the pressure on the discharge of the main control valve. This, in turn, decreases the temperature of the controlled liquid. Demand for more steam will be satisfield until the effect of the lever is entirely nullified, under which condition the pressure pilot limits the steam pressure supplied to the system.

The regulator shown in Fig. 4-12 is also designed for steam service. At low temperatures the temperature regulator shown at lower left is open, and the pressure under the diaphragm holds the line regulator open. As the controlled temperature increases, the pilot closes so that pressure under the diaphragm is relieved through the needle valve in the line to the downstream connection. The large diaphragm unit is a pressure regulator which closes the line valve in event of excessive increase in line pressure. Temperature is controlled by varying the pressure of the condensate to position the temperature regulator. Sensitivity to temperature changes is altered by the setting of the needle valve.

Special Valves

Many special valves have been developed for use on refrigeration units, storage water heaters for household use, heating and ventilating, flame-failure monitoring, etc. Most of these valves are adaptations of one or more of the principles discussed.

Fig. 4-13 shows a pilot-flame monitor for gas-fired systems. As it requires no external source of electricity or air, it can be called a "regulator" of a special type. A thermocouple (actually several couples in series) in the pilot flame, develops a millivoltage (such as 500 mv) sufficient to actuate the armature of an electromagnet. As long as the pilot is lit, the current in the electromagnet holds the flapper in a position such that the valve in the gas line is open; if there is no pilot flame the flapper closes the vent; the line pressure then closes the line valve.

PNEUMATIC OR ELECTRONIC CONTROL—

HAROLD W. ALYEA
Johnson Service Company

WHEN TREATING a controversial subject such as this, it is unlikely that any writer can escape without being accused of bias. It is well to dispose of this matter at once. The company with which the author is associated manufactures both types of controllers. Although it has been identified with pneumatic controls for over 70 years, it was perhaps the first to introduce a commercial electronic control in the heating field, having done this more than 17 years ago.

These years of experience with both types of controls have led to two conclusions: (1) that there is a

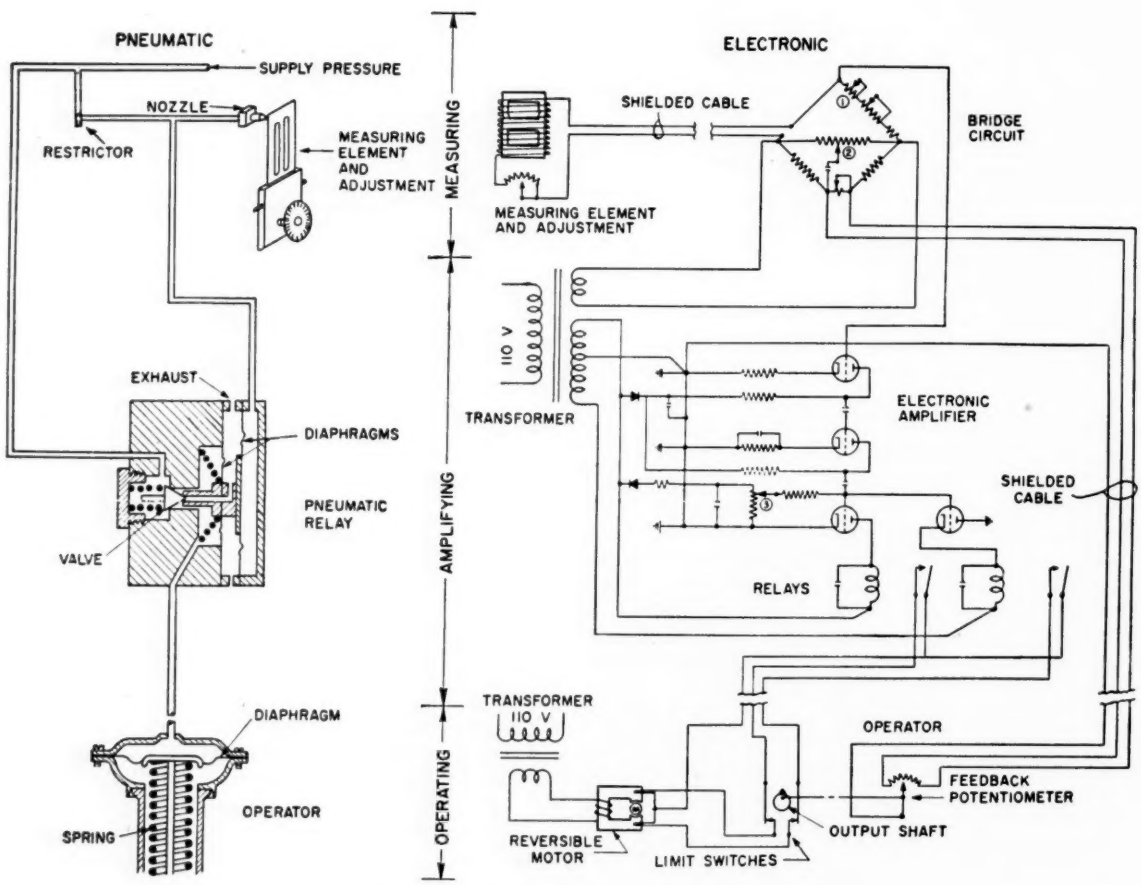


FIG. 1. COMPARISON OF pneumatic and electronic control systems for heating and ventilating application.

Which for Heating, Ventilating and Air Conditioning?

place for both types and (2) that in most heating, ventilating and air-conditioning applications pneumatic controls are superior to electronic controls at present. The writer denies any bias but freely admits a preference for reasons explained in the following.

As the title indicates, this discussion is confined to controls for heating, ventilating and air conditioning applications. While much of it also applies to industrial and process applications, these are beyond the scope of this article. Neither are we considering the average residence, where pneumatic controls are seldom used because of the limited size and the nature of the installations.

Simplicity

Reference to Fig. 1 leaves little doubt as to which is simpler.

Adjustment

Besides being more complex in construction, an electronic control system also is more complex to adjust.

Performance

Proponents of electronic controls emphasize the faster response of the measuring elements. This is only natural, but it tells only part of the story. Of importance is the time lapse between a temperature change in the medium being measured and the corrective change in temperature to counteract it.

Adaptability

How conveniently do the two systems adapt themselves to the various control requirements of heating, ventilating and air conditioning systems?

Because the connection between the measuring element and the controllers in an electronic system is a pair of wires, these systems lend themselves to centralized location of the controllers. The distance between the measuring element and controller may be any reasonable value if the wires are shielded and a sufficient range of resistance and capacitance balance is provided. However, recent developments in pneumatic control systems have brought many similar transmission features into a price range which makes them economically feasible for comfort control work. Thus they are now able to compete in this category with electronic controls. If centralized location of control apparatus is desired it can be obtained with either system.

The author of this article is Chief Field Engineer, Johnson Service Company, Milwaukee, Wisconsin. Mr. Alyea is a member of the American Society of Heating & Air Conditioning Engineers.

Averaging Control

An area in which electronic controls are considered by some to have the edge over pneumatic controls is in averaging the temperature response at several locations.

Reliability

Reliability depends not only on the number of components subject to failure, but on the nature of these components and how they are used. Pneumatic controls not only have fewer components but have very few subject to failure.

Summary

Many other articles have been written on this subject. Although these articles are aimed primarily at process control applications and the more sophisticated instruments characteristic of this realm of control, nevertheless much of what they contain also applies to comfort control installations. If electronic controls were considered superior to pneumatic controls in any important respect, surely the first place one would expect to find electronic controls predominant would be in the process industries. This is not the case.*

In no major category does there seem to be any clear-cut superiority of electronic controls over pneumatic. Certain features peculiar to electronic controls make their use more convenient. In the broad picture, however, pneumatic controls are simpler in construction, have fewer and simpler adjustments, their operation is more readily observed, they are easier to service and more economical to maintain. They are versatile in application, provide excellent performance, and have an enviable record of reliability over many years of use.

*This picture changes somewhat when considering more sophisticated control actions and systems. Perhaps the single most important factor to consider is PERFORMANCE, and evidence exists that some critical performance objectives demand the high-speed response of an electronic system.—Ed.

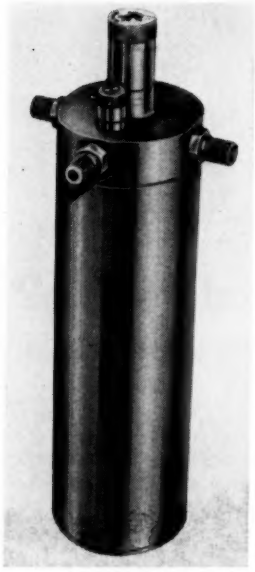


FIG. 1. PROTOTYPE of new large-capacity, self-contained, absolute-pressure controller.

This extremely sensitive Cartesian-diver-type self-contained absolute-pressure controller has set-point memory and uses a balanced orifice for high flow capacity.

Pressure Control by

CARTESIAN-DIVER PRINCIPLE is named after the French scientist, Decartes, who first defined it as far back as the sixteenth century. Consisting simply of an inverted float immersed in a liquid and containing trapped gas within it, the diver moves with the slightest change of pressure on the liquid. This motion is so sensitive to pressure changes that a barometer based on this principle and made by an Englishman in the early part of the eighteenth century could detect the infinitesmal changes in atmospheric pressure caused by the motion of clouds overhead. A simple self-contained and highly accurate pressure and vacuum controller of high sensitivity can be made by applying the Cartesian-diver principle. Many thousands of instruments using this principle are already in use in laboratories.* Fig. 1 shows a new unit modified for industrial use.

Principle of Operation

The schematic drawing (Fig. 2) shows both direct- and reverse-acting operation. The sensing element is an inverted can floating in an annular pool of mercury. The float is guided by a ball-bearing bushing to assure frictionless motion. The three-way valve shown is in a line between the volumes above and under the float. Any desired vacuum or pressure from a moderately high vacuum of 0.1 mm Hg to 500-psig pressure can be set by leaving the valve open until the system is at the desired vacuum or pressure. Closing the valve at this point seals off the volume under the float. Any change in pressure above the float will now cause the orifice to open (or close) to maintain the pressure.

The magnification factor of the float (ratio of linear motion of float in inches to pressure change in inches of mercury) can be adjusted by selecting suitable inside and outside diameters of the float and annular space containing the mercury. This factor can easily be made as high as 10, and in larger-sized units as high as 100.

One of the difficulties of the laboratory instrument has been the necessity of sacrificing sensitivity for capacity when a larger orifice is needed—that is, the larger the orifice, the smaller the sensitivity because the force across the orifice (area of orifice times pressure differential across orifice) must be overcome by the float. The larger this unbalanced force, the smaller the sensitivity. Most of this difficulty can be eliminated by using a balanced orifice as is commonly done in balanced valves. A well-balanced orifice can give at least ten times the capacity of an unbalanced orifice at the same sensitivity. The balanced orifice and seal comprise two parallel O-rings coaxial with the float (above float in Fig. 2) which engage two cylindrical surfaces also coaxial with the float. The seals move with the float on an extension rod, and the vertical position of the cylindrical surfaces of the orifice can be adjusted.

*Gilmont, R., *Industrial and Engineering Chemistry, Anal. Ed.*, Vol. 18, Page 633, (1946). Also *Analytical Chemistry*, Vol. 23, Page 157, 1951.

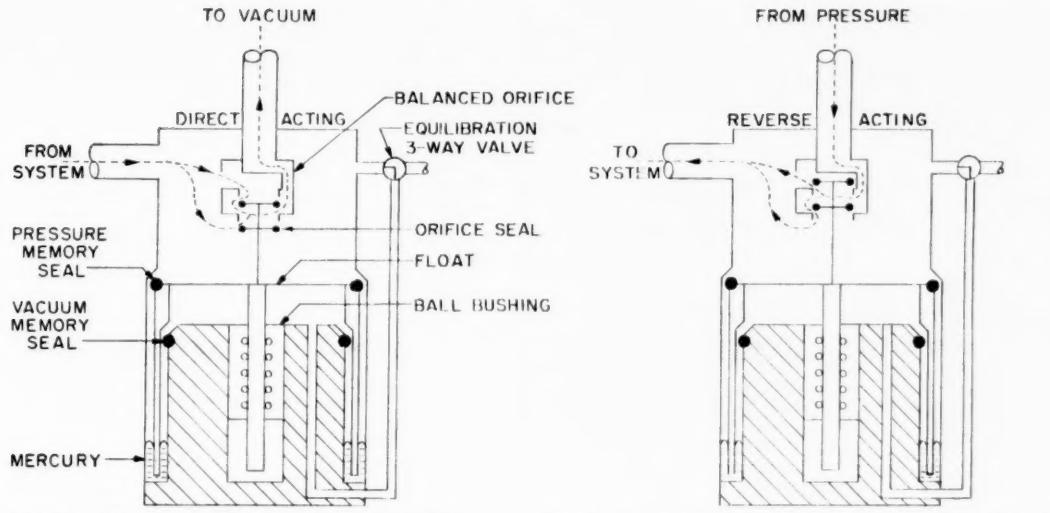


FIG. 2. SCHEMATIC DIAGRAM of controller showing direct action for vacuum control, (left) and reverse action (right) for pressure control. In former, orifice seals when float rises; in latter orifice seals when float falls.

Cartesian Diver

ROGER GILMONT, ISADORE GEPNER, BERNARD HANLON
Manostat Corp.

EARL HITCHCOCK, DONALD SALMON
Hoke, Inc.

For direct action the orifice is closed off by a rising float; for reverse action the orifice is closed off by a falling float. Either action is possible in the same instrument because the seals can pass through the orifice in either direction by moving the orifice up or down to its maximum or minimum position. During this transfer operation, the "memory seals" on the float hold it in alignment while the orifice seals pass through. The *pressure memory seals* are O-rings that seal the unit when the float reaches its uppermost position; the *vacuum memory seals* are O-rings that seal the unit when the float reaches its lowest position. These seals seal off the pressure under the float with a very positive action.

Vacuum Control

Normally the direct-acting orifice is used for vacuum operation; the reverse-acting orifice is used for pressure operation. Thus, for vacuum operation, the system is connected to the region above the float, and the orifice outlet is connected to a source of vacuum. The desired absolute pressure is sealed under the float by closing the three-way valve after equilibration at the desired pressure.

When the system loses vacuum due to leakage (increases in pressure) the float falls and opens the orifice, permitting the vacuum source to reduce the pressure to the set value. At equilibrium, the orifice adjusts itself to such a size as to just balance the amount of leakage. Owing to the high sensitivity of the float and the larger area of the balanced orifice, relatively large changes in flow result from small changes in pressure.

When the system is shut down and air admitted, the float drops until the vacuum memory seal is seated, which in turn seals off the trapped reference gas under the float. When the system is started up again, the float will rise when the correct pressure is reached, and it will control at the previous setting. Hence the instrument "remembers" its setting.

Pressure Control

For pressure operation, the reverse-acting orifice position is used and a source of pressure is applied to the orifice outlet. After setting the desired pressure under the float, the source of pressure will supply gas to the system as needed. Any reduction in pressure of the system will raise the float and open the orifice. Again, the orifice will adjust to a size which will exactly balance the loss of pressure from the system due to leakage. When the system is closed down and allowed to come to atmospheric pressure, the float will rise and close off the pressure memory seal, which will seal the trapped reference gas under the float and maintain it until the system is started up again.

Differential Control

For differential control, the region under the float can be connected to a reference gas through the three-way valve. This reference gas can be atmospheric

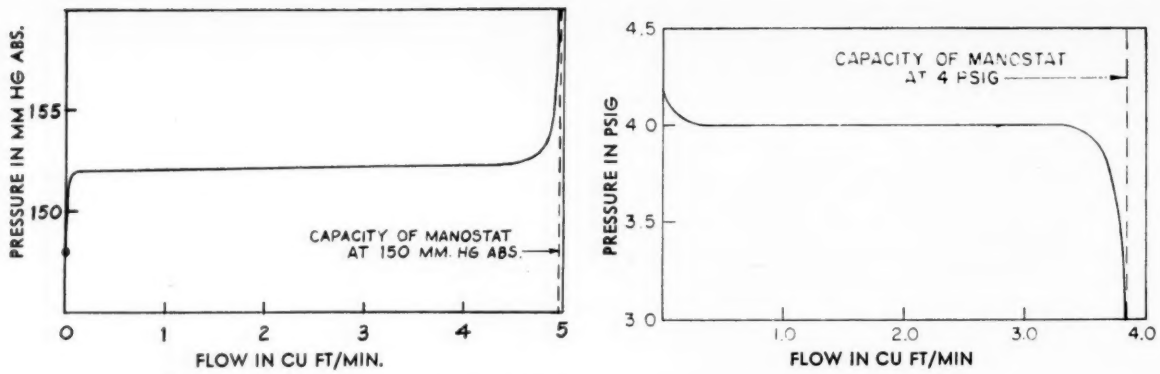


FIG. 3. OPERATING CHARACTERISTICS under vacuum (A) and under pressure (B).

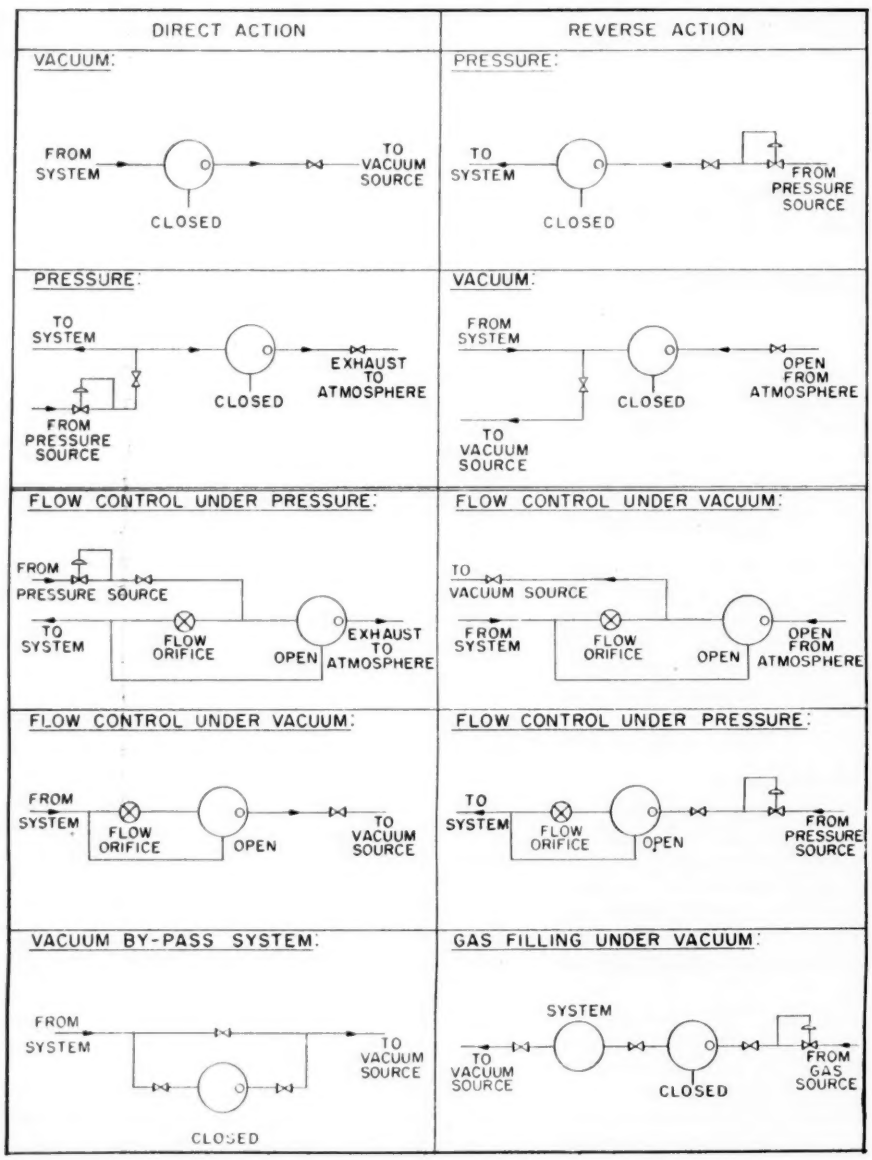


FIG. 4. VARIOUS APPLICATIONS of controller. "O" indicates orifice outlet of manostat.

pressure, a vacuum, or a pressure, as required.

Under certain conditions, the direct-acting orifice can be used to control pressure, especially under conditions where the system is generating gas rather than losing it. Operating in this manner, the manostat will exhaust any excess pressure so as to maintain the system at the set pressure. In a similar way the reverse action can be used for vacuum control when the system is losing gas instead of gaining it. Here the manostat will permit air or gas to enter the system as needed to maintain the set absolute pressure.

Design and Construction

In the actual instrument the connecting tube with the 3-way valve is an integral part of the instrument, consisting of two concentric tubes that connect the volumes above and below the float. O-ring seals are used throughout to give leakproof operation with mechanical rigidity. All metal parts are anodized aluminum, except those which require high precision or strength (valve parts, ball bushings and guiding rod of float); these are made of stainless steel.

Performance Characteristics

The relationship between absolute pressure and flow through the manostat has been determined experimentally for a typical pressure and vacuum setup. The results of two such experiments are shown in Fig. 3. No theoretical means has been developed to date to predict these curves either for the balanced or unbalanced orifice. Experiments with both types of orifices indicate that the slope of the straight-line portion increases with increased orifice size and decreases with increased magnification factor of the float. The balanced orifice gives slopes considerably less than for corresponding unbalanced orifices. There also appears to be an optimum-size diameter of orifice, or at least a minimum size at which point further reduction in size does not reduce the slope. Studies of the relationship between slope and intentional unbalance introduced into the balanced orifice indicate that it may be possible to achieve negative slopes (indicating instability); therefore, zero slopes may be possible at the proper conditions of unbalance. It is hoped that further experimentation will lead to a more complete theory for predicting the slope and other characteristics of the pressure-flow curves.

The balanced orifice with O-rings permits dead-end operation— that is, pressure control with no flow. This condition has never been possible with the unbalanced orifice of the laboratory type, where a very small flow was needed to overcome the slight amount of leakage at the orifice. The balanced orifice gives positive closure with a very small difference in pressure, especially as the diameter of the orifice is decreased.

Typical Installations

General types of installation are shown schematically in Fig. 4. Special attention should be given to the application involving filling with gas under vacuum, such as filling electronic tubes with specific gases. Fig. 5 shows vacuum tubes being filled with hydrogen to an absolute pressure of 1 mm of mercury with a deviation less than a few hundredths of a mm. After considerable experimentation with many types of controllers, Mr. Ruttenberg and Mr. Powell of the Amperite Corp. concluded that the Cartesian manostat was the only instrument that worked satisfactorily.

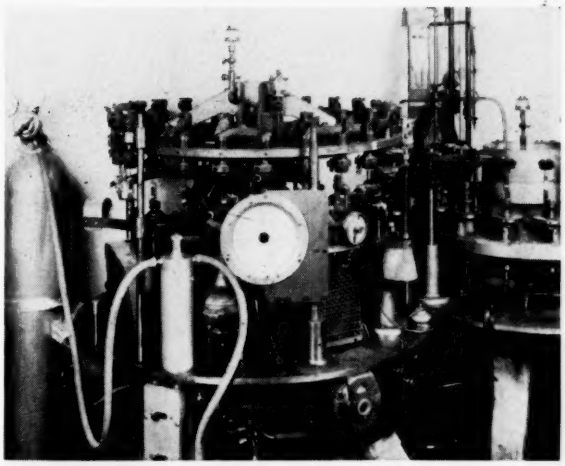


FIG. 5. CARTESIAN MANOSTAT controlling the absolute pressure of hydrogen-filled electronic tubes. These tubes are first evacuated and then filled with pure hydrogen to 1 mm Hg absolute pressure within a few thousandths of a mm. (Photo courtesy Amperite Corp.)

Another application uses the Cartesian manostat as a pressure transducer. Here the motion of the float can be converted into an electrical signal by replacing the orifice with a differential transformer. Theoretically this can detect as little as 0.002 micron of mercury differential pressure. Preliminary experiments indicate it may be possible to approach this theoretical limit.

One major drawback is that the gas trapped under the float is temperature sensitive. For this reason a *temperature compensator* has been developed. The compensator uses the thermal expansion of mercury whereby the orifice seals are attached to a plunger which is pulled into a sealed mercury chamber when the mercury expands owing to temperature rise. The downward motion of the orifice seal exactly counterbalances the upward motion of the float caused by the expansion of the reference gas. The two diameters of the differential plunger must be adjusted in accordance with the volume of the mercury reservoir, the dimensions of the float, and the volume of trapped gas under the float.

Experiments to date show that this compensator can be made to work on larger units. Smaller units require extremely close tolerances on the compensator parts in order to get satisfactory action, and require further experimentation.

Associate Engineer Donald A. Patterson demonstrates a problem in pluggable unit layout.

Field Engineering Instructor Joseph Rechloff explains basic display console functions at IBM, Kingston, N. Y.

Associate Engineer Robert M. Blake points out a feature of an advanced magnetic tape circuit development.

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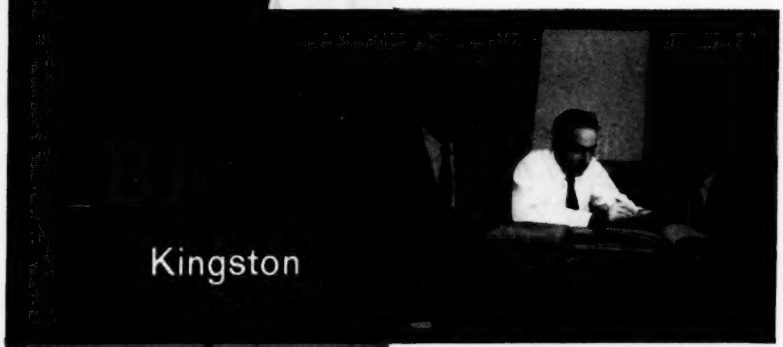

Staff Engineer Michael S. Zucker and associates plan electronic digital computer systems.

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Computer Student Stanley J. Ostrowski studies wave forms in the IBM Computer Engineering School laboratory.

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DIGITAL Automation—No. 22

History of checking procedures in Eniac, Binac, and Univac reveals the state of the art of digital-computer fault diagnosis and checking procedures. Trend is to automatic built-in self-checking procedures. Techniques include parity check, and use of odd-even check points and odd-count codes.

CHECKING CIRCUITS AND DIAGNOSTIC ROUTINES

J. PRESPER ECKERT, JR.

Remington Rand Univac Div. Sperry Rand Corporation

THERE are basically two kinds of machine faults which can cause trouble in an electronic computer installation—permanent failure of a component or circuit and intermittent troubles.

The *permanent fault* is simplest to locate. Obvious examples are blown fuses, shorted tubes, open resistors, etc.

Intermittent troubles can be classified as catastrophic or casual. What we call catastrophic faults are those intermittent troubles of non-marginal nature with long time-constants that are not usually caused by faulty design. Such troubles might result from a loose connection subjected to vibration or random shocks. Good logical or electrical design cannot anticipate many such situations, nor can the best maintenance staff in the world be sure of finding the trouble swiftly. A connection can open and, before any definitive evidence can be gathered, it can close again.

The casual fault is that which remains after the compromises of the ideal logical or electronic design with the necessities of economics. An example would be the occasional dipping of a pulse below a threshold, with resultant error or inconsistency.

The purpose of fault diagnosis is two-fold; we want to determine *what* is wrong, and we want to gain some idea of *where* the trouble can be found. The engineer's diagnostic tools are (1) checking circuits built into the computer mechanism. and (2) diagnostic routines or check. The former are more or less automatic; the diagnostic routines and program checks require the cooperation of operator and programmer, and frequently demand some *intuition* of the cause of the trouble.

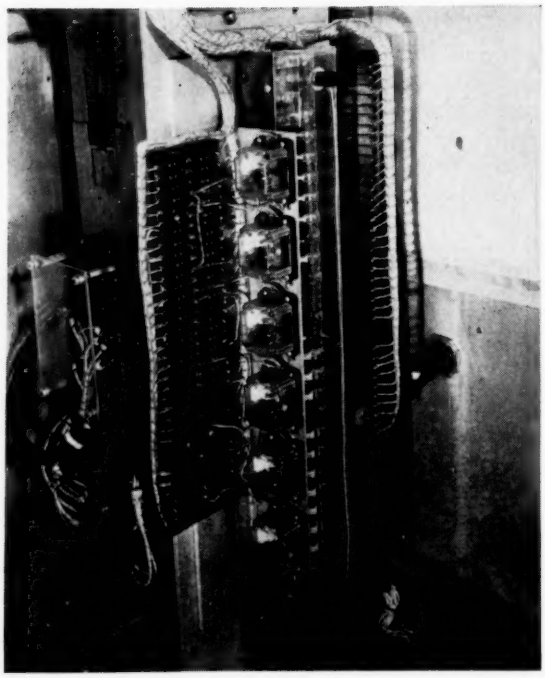
Diagnostic routines also consume valuable time and permit propagation of errors throughout the computer. Checking circuits, functioning automatically as the computations are performed, consume little or no time and do not allow the propagation of errors because they stall the computer on the discovery of an error. For large-scale computers designed for commercial and business use the most efficient system for error detection and fault location is one that is built into the machine and functions automatically under computer control (until such time as computers are built along simpler logical lines and of components more reliable than those currently used). At the present time there is little evidence of the economic superiority of programmed systems over built-in systems.

Eniac System

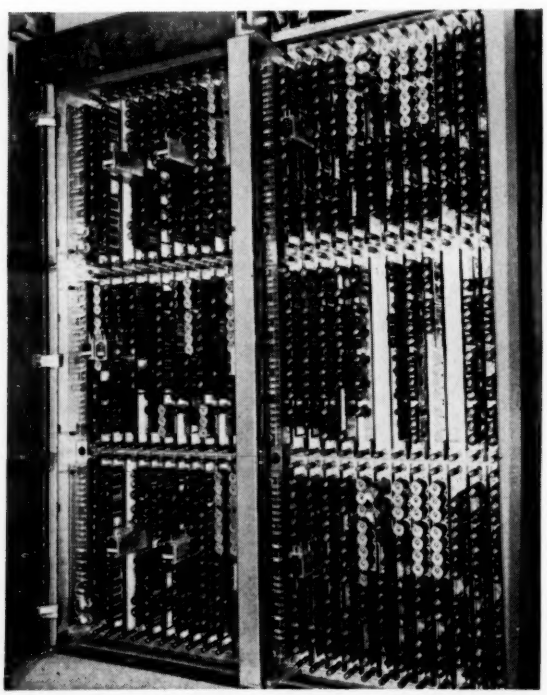
The diagnostic routines first used with the Eniac in 1945 were of four basic types. The principal diagnostic test was an *omnibus routine* containing every possible computer operation and using every control function; it investigated every section of the computer many times. Performing the test required about 10 minutes. This omnibus routine was primarily intended to locate permanent faults. As it repeated each operation many times, it also frequently tracked down faults of the casual and catastrophic types. Normally it was used once a day.

Eniac's second test was similar but required only about a minute and a half. It was used about once each operating hour and tested only the more-frequently-used portions of the computer, with fewer operations than the long routine.

The third checking operation consisted of taking differences on the problem, using the accumulator of



INTERNAL OPERATIONS OF THE central computer are continually checked by monitors that detect overheating, signaling the location of potential trouble before it develops.



USE OF DUPLICATE circuits is one basic checking technique.

a tabulator for subtraction, while at the same time printing out the answers.

The fourth and final checking operation consisted in running each problem twice and comparing the results to check for any intermittent fault which might have occurred during either run.

The probability that a machine fault could escape detection by this assortment of tests was small. However, the duplicate runs could not expose errors that occurred only on certain combinations of numbers or instructions; if these combinations were not included in the short test, the troubles would escape detection. The differencing of the results by the tabulator was therefore needed as an additional check. This also helped detect program error.

Defects of Original System

This system of checks looked good. However, it proved to be both hazardous and uneconomical.

The costliness of the procedure is evident; performing the tests and running the problem twice absorbed at least 60% of the available computer operating time. The procedures exposed the existence of errors, but helped little in locating the troublesome intermittent failures that produced the errors.

A serious disadvantage was that the tests were run at the discretion of the human operator. Operators, under the pressure of work or simply owing to normal human laziness, sometimes tend to omit them. No amount of cajoling or threatening could make an operator pay strict regard to the superimposed system of checks. This leads one to the conclusion that an automatic system must be automatically checked, or else one must have the assurance (impossible to give) that it cannot be wrong.

These experiences with human frailty, and with the problems of fault isolation using even the best diagnostic routines, indicated the advisability of including within a computer, and under its control, circuits which would check for errors and inconsistencies and which would be designed also to help locate trouble.

With the larger memories and even higher speeds of the current computers the situation is somewhat less critical because the checks and reruns can be included in the original program to reduce operator tampering. The principal loss is usually about 60% or more of the computer time, which is required to perform the omnibus routine and the duplicate problem runs, to store the intermediate answers, and to perform the answer comparison routine. The accompanying loss of 60% of storage area in the memory is also an important consideration.

Binac System

With the design of Binac we moved away from programmed tests and incorporated instead the principle of complete computer-checked operation. The Binac consisted of two identical and complete computers. There was no temptation for the operator to cheat on test routines because there were no test routines except those used in early de-bugging and certain preventive maintenance checks. The two computers checked each other at all times.

The comparison of the two answers produced by

the two halves of Binac was accomplished very simply. A pair of comparators, each operating from a different one of the two power supplies, compared all the data passing over the main transfer bus of the two computers. Any discrepancy stopped both computers simultaneously. This, incidentally, satisfies the most critical requisite of diagnosis, namely that faults be detected as they occur so that the faulty state can be fully retained for complete analysis.

Univac System

Experience in operating the Binac convinced us of the value of duplicate units and of continuous comparison of results as they are obtained. In designing the Univac system, this idea was modified somewhat to save equipment. For example, only those components of Univac are duplicated for which no other valid means of checking could be found with a reasonable expenditure of engineering, or in which the simplest means of locating the trouble would be interchanging duplicate chassis.

The memory is not duplicated, for example, but is *parity checked* instead. As there are many identical memory chassis, the ability to locate troubles by chassis interchange already exists without additional expense for duplication.

All pulse-group transfers are also parity checked. Some especially intricate parts of the Univac are both duplicated and parity checked, so that the trouble is not only caught, but the offending unit designated. *In many cases, the checking circuits themselves are duplicated.*

As a result of a careful evaluation of probabilities in checking requirements, 35 checking circuits were put in Univac.

Let us discuss the detection of catastrophic errors. Assume that a connection was broken somewhere in the computer. This could cause any one of three different errors: it could read all binary zeros on to subsequent stages; it could read all binary ones; or it could possibly pass random pulse-groups. Since Univac recognizes only an *odd-count code**, the first zero train to pass an *odd-even check point*** would stall the computer.

The all-ones condition would, however, pass the odd-even check point. Hence Univac has a detecting circuit which inspects the blank spaces between each twelve-character word. Any pulses in this space stall the computer. Furthermore, the a-c coupled circuits would bog down with a pulse train of all ones (in essence, a steady-state signal) because the restoring circuits cannot handle this type of signal. This would produce errors noticeable to an odd-even checker.

To detect the random pulse group we rely on both duplication and parity checking*. Each pulse group that passed in the time span allotted for a single character would have a 1:2 chance of passing the odd-even check, but this chance is for a single character, and rapidly improves to $1:2^{12}$ or 1:4096 for pulse groups occurring in as little time as 40 microseconds. Remember, too, that we are presuming a random situation caused by a catastrophic fault, which means its time constant is probably much longer than one word, so that the chance of such an error going undetected would, in general, be much better than even one to four thousand. In addition, the chances of a random pulse group passing a comparison check with correct pulse train in the duplicate version of the same circuit are dim indeed.

In all cases the checking circuits or comparison circuits stall the computer as soon as a discrepancy is detected. The importance of stopping operation as soon as an error occurs cannot be too strongly emphasized, especially considering the operating speed of an electronic computer. In considerably less than human reaction time an error easily can be propagated throughout the entire system. This makes isolation of the fault extremely difficult, and rapid isolation of the faulty elements from among thousands of possible culprits is the principal troubleshooting challenge in any large-scale electronic device.

The function of a check scheme is to inform the operator of an error or a fault and then, if possible, to assist him in isolating the trouble. The principal objection to checking circuits and duplicated equipment has been cost. While their cost is high, it is an initial cost only; they reduce maintenance expense. Relying on diagnostic routines and programmed checks requires a smaller initial cost but uses up costly computer time and programmer time to evolve and maintain them. Univac does make use of some diagnostic routines in checking out the equipment during factory tests and after performing corrective maintenance. Some test routines contain purposely contradictory or inconsistent instructions to test the error circuits. Also, there are routines for checking the arithmetic circuits, the control and sequencing equipment, the input-output control circuits and tape units, the memory and memory controls, and the instruction decoders and encoders; a special routine exhaustively checks each of the checking circuits.

In addition, the entire memory is parity checked automatically every four seconds. This is not programmed, but built in (although the operator can elect to omit it). The test uses 1/25 of a second to check the entire memory without any time-out for waiting periods as the memory is scanned. With a 4-second cycle, only 1% of the computer time is consumed.

Because of these checking circuits the user does not have to rely on the operator's performing test runs, on a programmer's skill in coding a program check, a test problem, or a diagnostic routine. Isolation of a faulty circuit is simple because the computer stops at the instant a fault is detected. The checking circuits give an instantaneous warning when trouble comes, so that the trouble is located and not propagated.

---

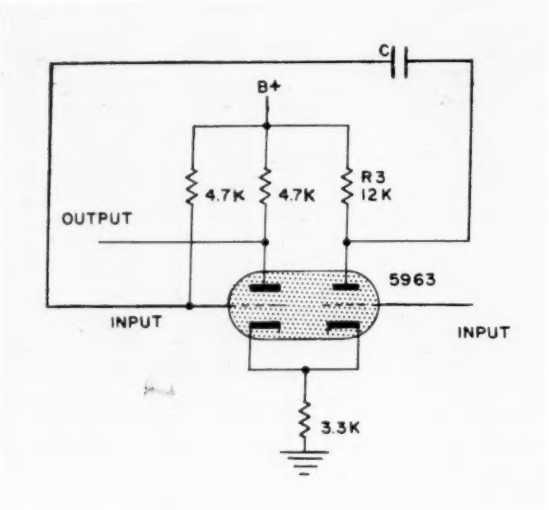
*An odd-count code is a code in which every character is represented by an odd number of binary digits. In the case of Univac, this number is seven.

**An odd-even check point is a point in the circuitry of the computer at which an odd-even check is made. An odd-even check is simply a counting of each character passing the check point. If the counting indicates an even number of binary digits, the system automatically indicates that an error has been made, since each Univac character contains seven binary digits.

*A parity check, in the case of Univac, is an odd-even check.

ONE-SHOT MULTIVIBRATOR

The one-shot multivibrator provides one rectangular pulse of constant duration and amplitude for each input trigger, and is used to generate a pulse of adjustable duration with fast recovery time. It differs from the bistable multivibrator in that it has only one stable condition (left-hand stage conducting, right-hand stage nonconducting). Hence 27-v positive pulse to grid at right, or 35-v negative pulse to grid at left causes regenerative action (via common cathode resistor) that quickly causes left-hand stage to cut off, and right-hand stage to con-



duct. This condition is not stable because the capacitor C will start to charge through R3, causing regenerative action that restores the stable condition. Output is one rectangular pulse whose duration T in usec is approx.: $T = (C)\ (0.08V - 0.6)$, where C is in uuf and V is voltage between grid and cathode of input stage at right.

Input: Left grid requires 35-v negative pulse minimum with 3-v overshoot and minimum duration of 1 usec; right grid (if used to trigger) requires 27-v positive signal, minimum, with 2 usec or more duration with overshoot clamped (by diode).

Output: 60-v positive pulse.

Output impedance: About 4.7K at 90% max. duty cycle.

Frequency range: 0 to 100 kc.

B Supply: 200 v at 12.5 ma.

Source: Circuit Z-8889, EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif.

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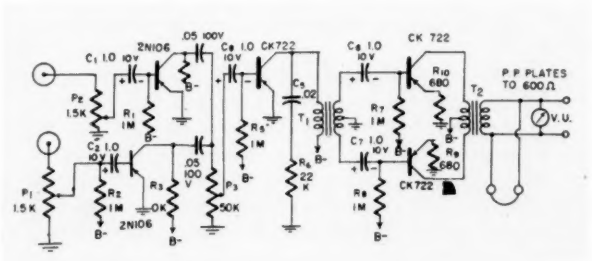
PORTABLE 2-CHANNEL MICROPHONE AMPLIFIER IS TRANSISTORIZED

Two independent microphone channels are provided in this transistorized mixing-amplifier, used for broadcasting remote events by a radio station. It is used with 250-ohm dynamic microphones, providing output level sufficient to feed telephone lines to the station. Independent gain controls P1 and P2 provide low-level mixing, selected for simplicity. P3 is the master gain control.



Miniature electrolytic capacitors were found to be suitable for interstage coupling except at the collectors of the low-level stages, where paper capacitors were used. Capacitors C1, C2, C6, C7 and C8 are electrolytics. Frequency response is corrected by C5 and R6 at the collector of the second stage.

A commercially available plate-to-600-ohm-line transformer provides push-pull drive to the output stage (transformer is connected for voltage step-down). Resistors R9 and R10 provide stabilizing degeneration. Transformer T1 is UTC Type 0-9 ouncer; T2 is UTC 0-10 ouncer.

Input: From two dynamic microphones.

Output: +4 VU normal program level, equivalent to 6.3 milliwatts.

Insertion gain: 65 db.

Load impedance: 600 ohms.

Source impedance: 250 ohms.

Frequency response: 3 db down at 100 cps; 1 db down at 15 kc.

Distortion: 3% at +4 VU output.

Noise: 50 db below normal program output.

CIRCUITRY

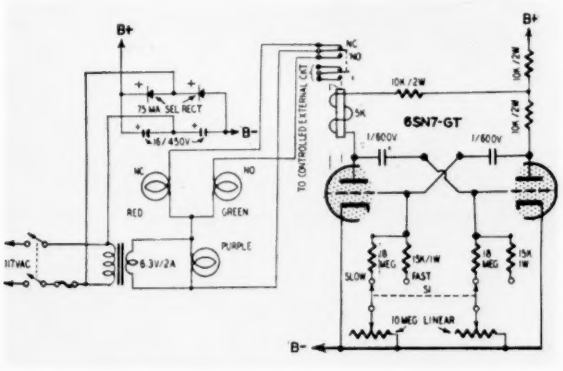
The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

Supply: 22.5 v battery at 5 ma.

Source: E. C. Smith, Radio Station WFIN, Findlay, Ohio; also *Tele-Tech* & *Electronic Industries*, Aug., 1955.

MULTIVIBRATOR CYCLE TIMER IS ADJUSTABLE FROM 1 CPM TO 60 CPS

The R-C constants in this multivibrator are continuously variable. Hence operation can be chosen anywhere in range of 1 operation per minute to 60 per second, a range useful in life-testing of relays, solenoids, motors,



etc. Speed of operation can be checked by observation of lights or with an oscilloscope on faster ranges. The B— bus must be insulated from the chassis, as is customary with voltage-doubler supplies.

Frequency range: 1 per minute to 60 per second.

B Supply: Voltage doubler operating from 115-v line.

Relay: Potter-Brumfield type CM-11-5000 or equivalent.

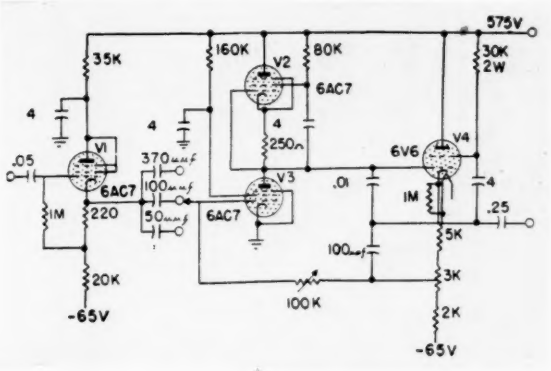
Source: H. F. Parks, Henry Francis Parks Laboratories, Portland, Ore.; also *Radio-Electronics*, February, 1956.

DIFFERENTIATOR

This is one of two differentiators used in series to measure acceleration (d^2x/dt^2) from a displacement signal (x) representing the ballistic impact of a projectile striking a steel plate. The circuit is almost identical to one developed at MIT Radiation Laboratory, and described in Vol. 19, *Radiation Laboratory Series*, by B. Chance et al. Original displacement signal is obtained from phototube that detects the missile position.

Input signal is fed to a cathode follower which has the differentiation circuit in its cathode circuit. Junction of the resistor and capacitor comprising the differentiator is held almost constant by the d-c feedback amplifier V3 and cathode follower V4. Hence current through the differentiating capacitor must be exactly proportional to the *rate* of change of the input signal, as is the output signal. Output changes exactly 6 db per decade over 3 decades of frequency on $\log_{10}$ scale (frequency range of 1000 to 1).

Three differentiation capacitors are chosen to accommodate various ranges of frequencies; the 50 uuf is used for a range of frequencies from 1 kc to 1 Mc; the 100-uuf capacitor is used from 300 cps to 300 kc; the 370-uuf capacitor from 100 cps to 100 kc. Note that this is a frequency range of 1000/1 in each case, but neither the upper nor lower limits can be considered as sharp.



High-frequency noise signals are amplified and exaggerated by the differentiation process. Hence frequencies of up to only 100 kc could be used when two differentiation circuits were used to obtain acceleration from displacement. Improvement was obtained by using only one differentiator to obtain velocity, then obtaining the acceleration curve analytically from the velocity curve by method of differences. This improved the bandwidth from 100 kc to 1 Mc; with photo-amplifier bandwidth of 300 kc, noise is less than oscilloscope trace width. The 2K, 3K, and 5K resistors in the cathode circuit of the 6V6 are 10-watt resistors.

The 1-meg resistor connecting the cathode to heater of the 6V6 is not critical; 100,000 ohms would serve as well to maintain the d-c potential of the heater at a proper level relative to the cathode and to prevent pickup by the cathode of heater-transformer hum.

The —65-v cathode tap adjusts the operating point of the 6AC7 and 6V6 to a linear portion of the characteristic because of the high value of B-plus used (575 v).

Function of V2 is to provide a high-impedance plate load for V3 and thus increase the gain of V3 (the cascode principle).

Function of the 0.01-0.0001-uf capacitance divider across the grid of V4 is to stabilize the feedback loop.

Range of useful frequencies (6 db/decade): 100 cps to 1 Mc in 3 steps.

B Supply: 575 v, unregulated, at 90 ma; —65 v, unregulated, negative tap on bleeder resistor of B supply.

Source: John C. Lindsay and A. Victor Masket, U. of North Carolina, Chapel Hill, N. C.; also *Review of Scientific Instruments*, July, 1954.

Automation in Airframe Production

Bendix Aviation Research Lab builds numerically-controlled milling Machine for The Martin Co.

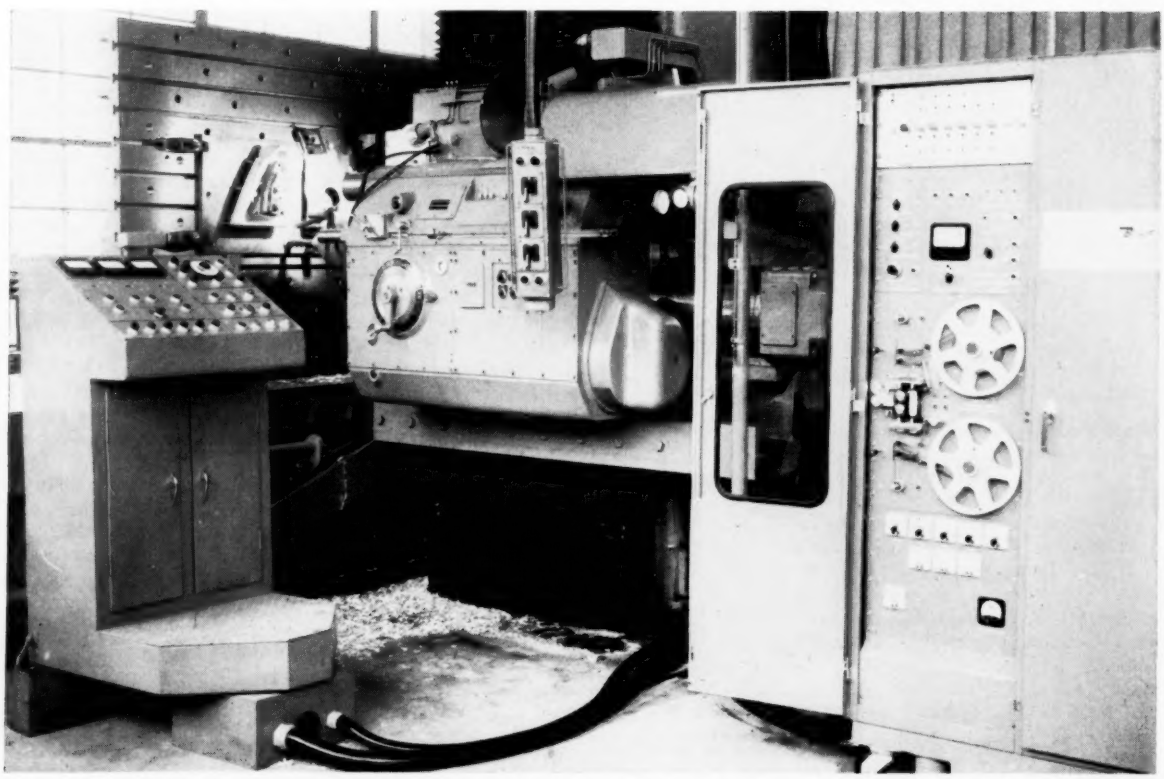


FIG. 1. NUMERICALLY-CONTROLLED 50-TON MILLING MACHINE which gets commands from perforated tape. Control unit is shown at right, operator's stand at left.

FIG. 2. CODED INFORMATION TAKEN FROM BLUEPRINT and put on punched paper tape by Flexowriter is translated by computing equipment into perforations on plastic tape. Computer is shown at right, auxiliary storage unit at left, and master writer on desk.

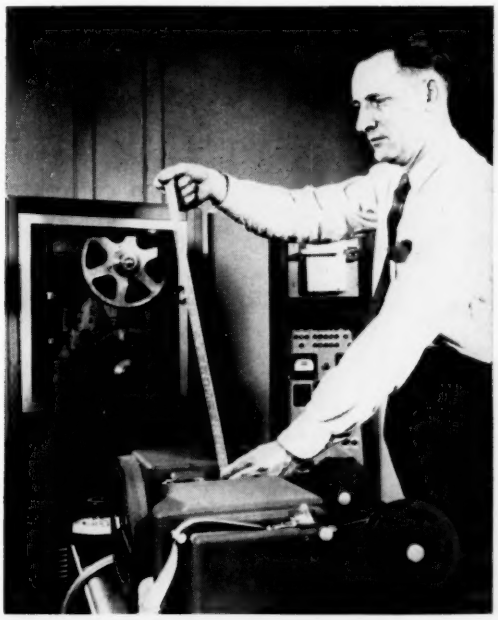


FIG. 3. CLOSE-UP VIEW of perforated plastic tape.

FIG. 4. OPERATOR AT CONSOLE performs only functions of (1) installing fixture and work piece, (2) loading and unloading of control tape, (3) changing of cutters, and (4) starting and stopping of machine.

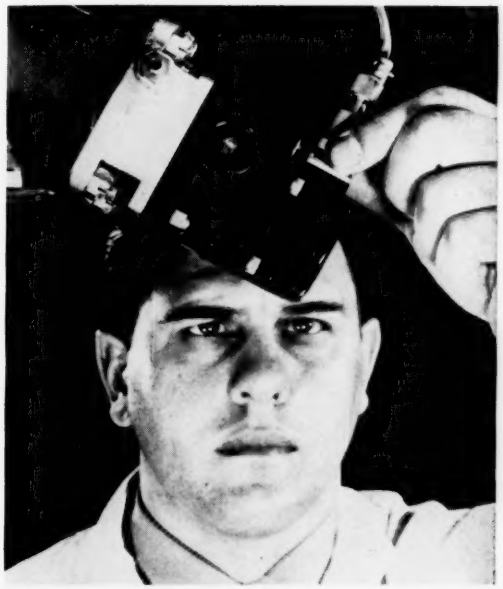


FIG. 5. SENSITIVE HYDRAULIC SERVOMECHANISM is checked periodically by operator. It controls milling machine slide movements to produce proper relations between cutter and workpiece.

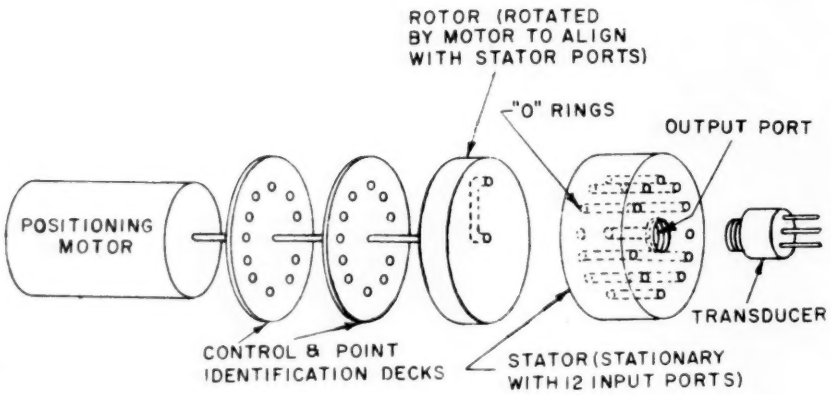
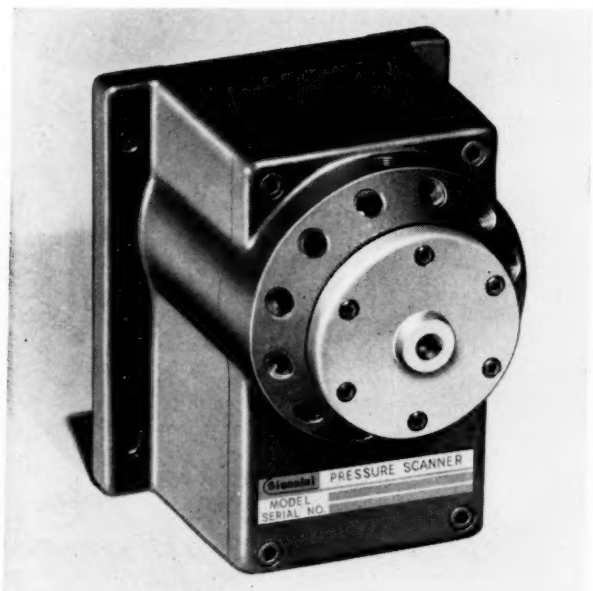


FIG. 1. SCANNER schematic.

This device pneumatically switches a number of pressure sources into a single output port providing an economical means of measuring a multitude of pressures with one transducer.

ROBERT J. MARMORSTONE
Giannini, Datex Div.



THE PRESSURE SCANNER consists of a stator having 12 input ports, and a rotor that connects any one of twelve input ports to the center output port (Fig. 1). The rotor is rotated to a desired position by a unidirectional high-torque motor acting as a positioning servo. The motor operates the rotor to any position externally selected by means of a switch. A 12-position switch inside the scanner unit is connected to an external 12-position switch so that when both switches are on the same position the motor circuit is opened and the motor stops (Fig. 2). A relay circuit in the unit provides dynamic braking to stop the motor when rotor and stator ports are in coincidence. An additional bank of contacts on the internal switch indicates rotor position either visually by lights or in digital form for recording devices. The positioning system allows points to be skipped or scanned in any desired sequence by remote control.

The scanner is also available with a step drive that can be controlled from a pulse input in the same manner in which a telephone-type stepping switch is driven.

The pressure scanner will operate over a range of from 0.1 psia to 350 psig, and can be used for dry air or non-corrosive dry gases. It is designed for a

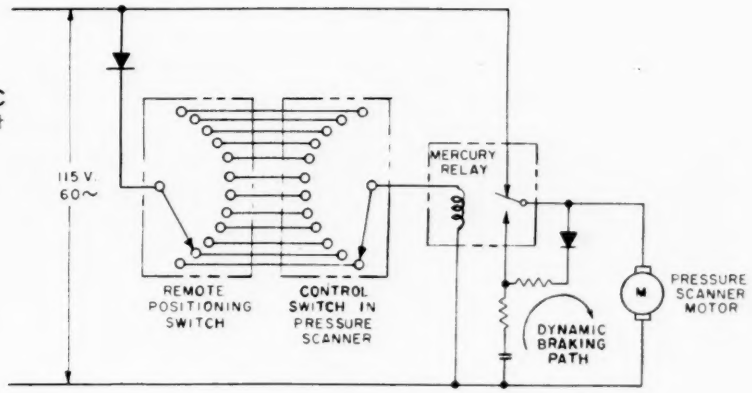


FIG. 2. BASIC control circuit

MULTI-PRESSURE SCANNER

normal industrial environment and will operate under ambient temperatures up to 150° F.

Accuracy and Calibration

In addition to providing an economical means of measuring a number of pressures, the pressure scanner can increase measurement accuracy. In general, figures specifying inaccuracies due to linearity and hysteresis are a percentage of full-scale reading (e.g., ± 0.5%). Usually, the figure quoted is a conservative value owing to the variable nature of hysteresis errors caused by random applications of pressures. The pressure scanner minimizes hysteresis errors by venting the transducer to atmosphere between successive ports in the scanning cycle. In this manner the unknown pressure is always applied in the same direction—upscale. The net result is a pressure-to-electrical conversion that provides excellent reproducibility.

Two of the 12 input ports on the scanner can be used also to apply zero and calibration pressures. A record of transducer and recorder calibration at the zero and calibration pressure points can be automatically recorded during each scanning cycle. The measured pressure can be referenced to the recorder zero and calibration readings to obtain a corrected pressure reading since the zero and calibrated pressure readings represent *exact* values on the measurement system calibration curve at the time all readings are being taken. Also, initial calibration upon installation can be accomplished with a minimum of effort.

Stabilization

When using a pressure scanner in multiple-pressure scanning systems, sufficient time should be allowed between successive scan points so that the pressure being switched to the transducer can stabilize. The delay time is determined by the over-all accuracy desired of the system. In most applications, the additional volume added to the pressure system by the addition of the pressure scanner will be a small portion of the total volume of the system. Thus, the addition of the pressure scanner will have a negligible effect on pressure stabilization time of the particular pressure channel. The output volume of the scanner illustrated in Fig. 1 between the point of line cutoff on the rotor to the output surface of the cap is 0.01 cu in. The input volume (between the input connector and the rotor) is approximately 0.1 cu in, but does not

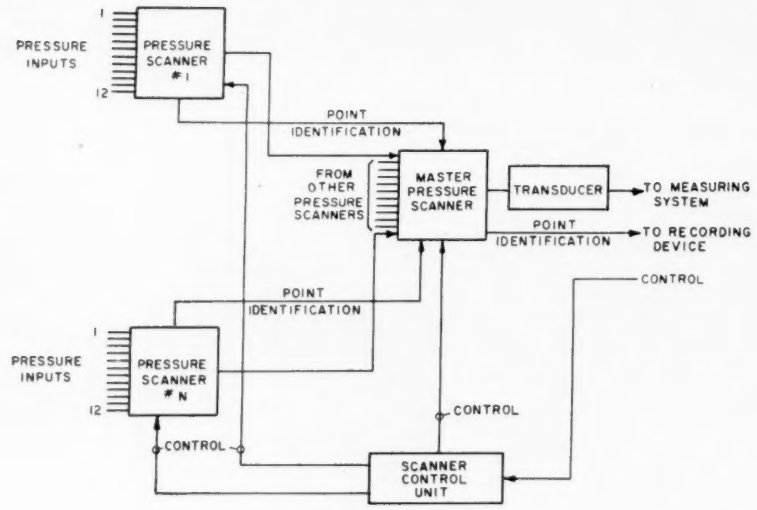


FIG. 3. BLOCK DIAGRAM of typical multi-pressure scanner system using one transducer.

affect operation because this volume is not switched. The use of a flush-diaphragm transducer might add 0.005 cu in to the total volume introduced by the scanner. Transducers with greater internal volume will have proportionately greater effect *depending upon other parameters of the input system.*

Stabilization time can be decreased by designing the pneumatic system with a short length of large diameter tubing. The effect of line volume on stabilization time can be readily illustrated by taking two typical pneumatic systems, the first with 18 inches of ¼" tubing from the pressure source to the pressure scanner and the second with 100 feet of ⅛" tubing. Relative stabilization times required for the transducers to read within 0.1% is 15 milliseconds for the first system and 600 milliseconds for the latter.

Typical Systems

By using one pressure scanner to interrogate twelve other pressure scanners, as many as 144 pressures can be measured with only one transducer. A block diagram of a typical system is shown in Fig. 3. The 144 pressure inputs are connected to the input ports of an additional pressure scanner. The output of the latter scanner will thus sequentially scan the inputs of the 144 pressure variables. This system is generally applicable where all pressures fall within the same range.

Where a plurality of transducer ranges is required, the input pressures are connected to the pressure scanner associated with the range which will offer greatest accuracy (Fig. 4). An increase in over-all system speed is possible over that of the single-transducer operation. As an example: assume a system contains ten pressure scanners that will be controlled in two groups of five each. While the transducers associated with the second group are being scanned, the first group is positioned to the next point. In this manner, the pressures of group number one are being stabilized while the transducers of group two are being recorded.

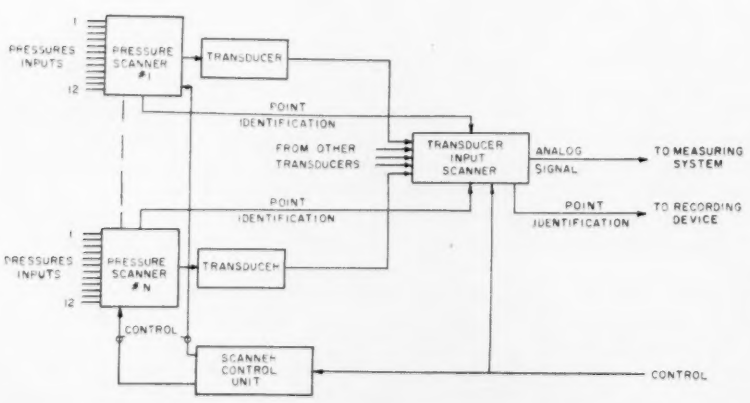
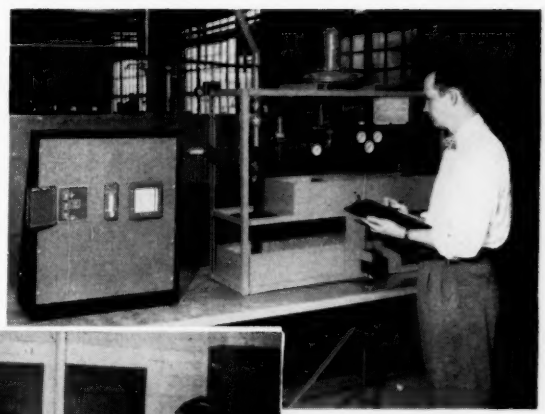


FIG. 4. BLOCK DIAGRAM of typical multi-pressure scanner system using one transducer per scanner.

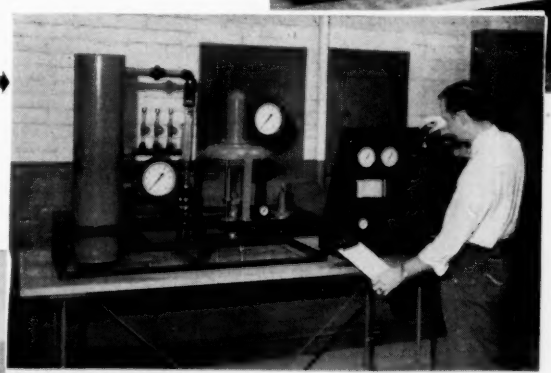
THE DYNAMIC response characteristics of a process control system are being studied with the aid of a Philbrick analog computer.

Instrumentation ⇄ Education

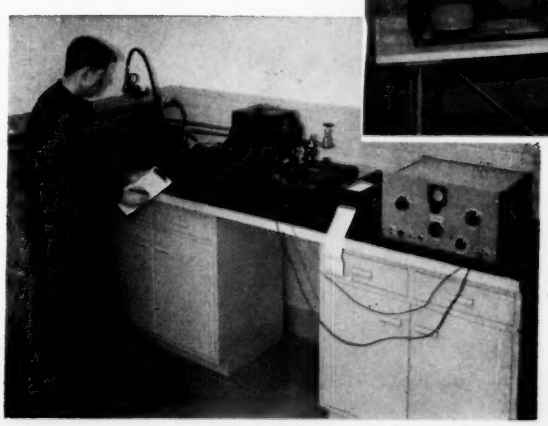
CASE Institute of Technology, Cleveland 6, Ohio, conducts a Summer Study Program on Process Control Theory. These pictures show how the basic problems of control response are tackled.



TRANSIENT RESPONSE test being made on a two-time-constant process with pneumatic controls.



TRANSIENT RESPONSE test being made on a two-capacity liquid process with electronic control system.



FREQUENCY-RESPONSE test is being run on a hydraulic control system.

During this International Geophysical Year (July 1, 1957 to Dec. 31, 1958) scientists of the US Department of Commerce are utilizing thousands of instruments—most of them new. The US National Committee for the IGY, organized by the National Academy of Sciences, looks to three scientific bureaus in Commerce for substantial contributions on three of the earth sciences. These are:

Water Bureau—meteorology;

National Bureau of Standards—ionospheric physics, the study of the electrified region from 25 to 250 miles above the earth that is so important to radio communications;

Coast and Geodetic Survey—geomagnetism, especially the part generated by electric currents high above the earth in outer space.

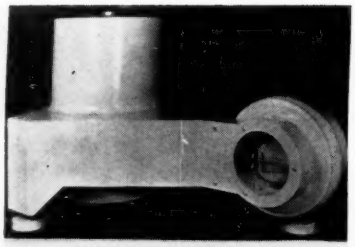
All three bureaus cooperate with many other US agencies and with scientists of over 60 foreign countries.

A fourth agency in Commerce, the Civil Aeronautics Administration, transmits IGY messages over its domestic and foreign circuits.

Commerce Department IGY Instrumentation

Coast & Geodetic Survey

THE COAST AND GEODETIC SURVEY conducts most of the US magnetic studies for the IGY. Since 1843 it has observed the earth's magnetism for mariners' and aviators' charts. It also contributes data on earthquakes, gravity of the earth, tide movements, and latitude and longitude.



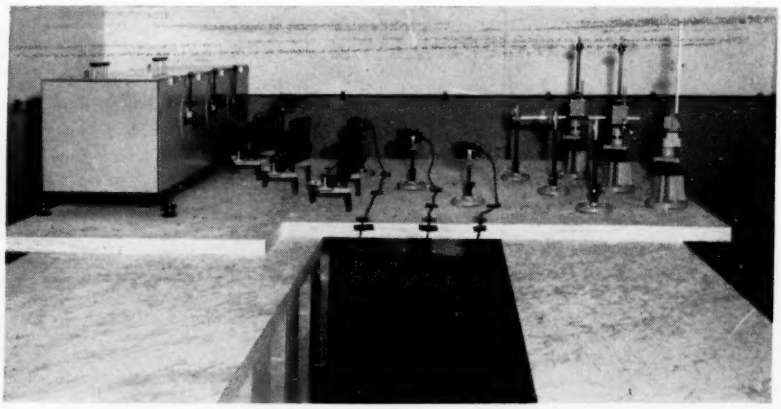
HORIZONTAL COMPONENT

VERTICAL COMPONENT

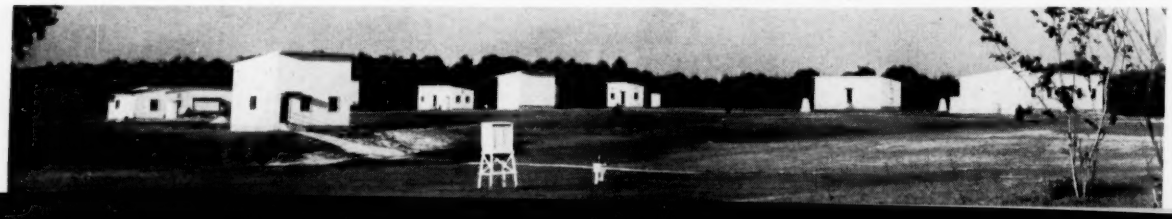
RECORDER AND GALVANOMETERS

IN THE BENIOFF SEISMOGRAPH delicately-balanced masses move relative to instrument supports when the ground moves.

RUSKA RAPID-RUN MAGNETOGRAPH is special IGY instrument. The three components at right are the variometers for horizontal direction, horizontal intensity, and vertical intensity of the magnetic field. Through an optical lever system, variometer deflections are photographically recorded in the unit at left.



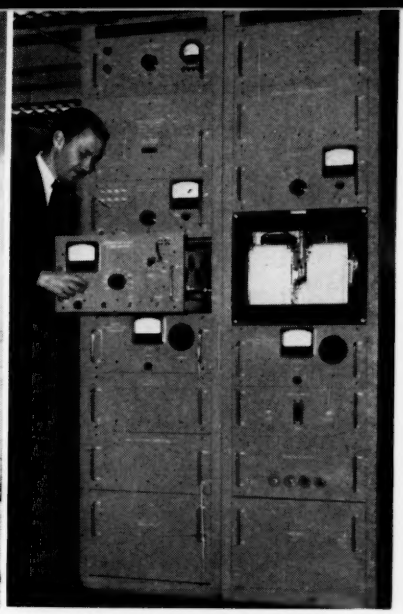
C&GS MAGNETIC OBSERVATORY at Fredericksburg, Va. The variation instrument buildings, absolute magnetometer buildings, etc. are isolated from one another to avoid interaction of magnetic components of instruments.



NBS Radio Noise Recording Program

The NBS has set up 16 radio noise-recording stations throughout the world to record radio signals generated by the more than 50,000 thunderstorms occurring daily on earth.

ONE OF THE WORLD-WIDE chain of recording stations designed by the NBS.

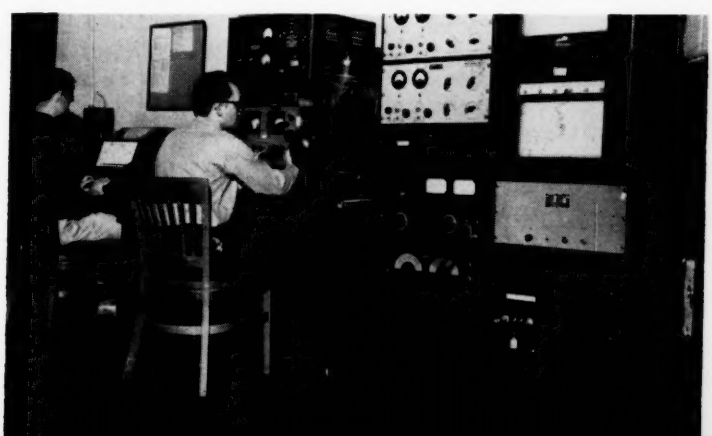


CHECKING A RADIO NOISE recorder at a field station of the NBS Boulder labs.

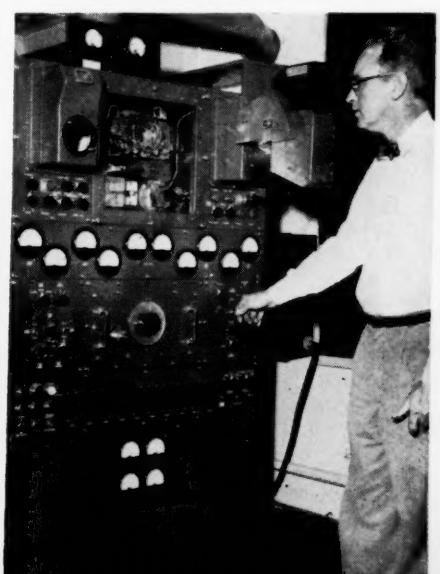
NBS World Warning Agency for IGY

Since July 1, the NBS radio forecasting center at Fort Belvoir, Va., has been flashing warnings to scientists throughout the world to redouble their observational efforts in anticipation of unusual activity in cosmic rays, aurora, earth magnetism, and radio propagation disturbances. Warnings are based on observations of sun's surface and soundings of ionosphere.

CONTROL ROOM OF World Warning Agency. Incoming teletype messages bring data on disturbances; outgoing messages warn of expected increases in disturbances. Wilson E. Higgins (extreme left) is at the teletype while Lynn Sholar operates radio direction-finding equipment. At right is equipment used to record the intensity of radio waves from distant broadcasts.



JOHN J. SULLIVAN operates the NBS-developed Ionosonde which sounds the ionosphere. Data are recorded on film.



HIGH-SPEED HIGH-

The Naval Ordnance Laboratory is engaged in a program to determine the pressure-volume-temperature relationships of some gases at high temperatures and pressures—up to 4000°K and 100,000 psi—where drastic requirements must be met with regard to gage performance. After a study of various techniques of pressure measurement, the design described in this paper was selected for development.

BASIC PRINCIPLE of the pressure gage is shown in Fig. 1. An x-cut quartz crystal is cemented on a steel plate, 1(A). The pressure on the plate bends it and stretches the crystal, 1(B). Consider the strain diagram, 1(C), for the line MM through the pressure-deformed plate. At point A the metal is under compression, which decreases as the distance from the surface increases. The median plane at 0 is neither compressed nor elongated. The elements are under increasing tension as the opposite side of the plate is approached. The crystal is likewise under tension, being cemented to elements on the plate that are elongated. This is indicated by C of Fig. 1(C). The crystal is quite thin compared to the plate, so the tension in the crystal along MM is essentially constant. This stretching of the crystal produces charges on its faces which depend on the applied pressure, and which, upon calibration, can be used as a measure of this pressure. The crystal acts as a piezoelectric strain gage.

A sketch of the pressure gage is shown in Fig. 2. The x-cut quartz crystal (0.005″ thick and 0.28″ in diameter) is cemented to the plate that forms the face of the gage with a thermosetting plastic cement, Araldite No. 1 (distributed by the Ciba Company of New York). The charges generated on the cemented side of the gage are capacitively coupled to the housing because the cement is non-conducting. The other face of the crystal is plated with gold. A spiral spring makes electrical contact with this surface. This spring is supported by a polystyrene disc through which passes the electrical lead to the recording equipment. The plastic disc is held in place by a retaining ring. The gage housings for the lower pressure ranges are made of 18-8 stainless steel and not heat-treated; for higher pressures they are made of Navy class-5 tool-steel heat-treated to Rockwell-C-scale 55-60.

Fig. 3 shows the manner of mounting the pressure gage in the compressor. It is mounted in a 1″ diameter well, 1-1/16″ deep, in the compressor wall. Over the gage face is a cover plate held in place by a retaining ring. Underneath the cover plate and retaining ring is an O-ring pressure seal. The purpose of the cover plate and O-ring is to seal the face of the gage to prevent the application of pressure to the side of the gage. This gage, especially for the case of thick face plates, is appreciably sensitive to side pressures. The frequency response of the side of the gage is limited by the annular region between the gage and the well wall. In order to eliminate the frequency-response limitation of the annular region it is necessary to locate the pressure seal at the face of the gage.* The clearance between the gage and well wall is about 0.005″. The cover plate is steel, 0.005″ thick. The natural frequency of the cover plate does not affect gage frequency response since it is held firmly against the gage by pressure. The spacer at the base of the gage sets the gage face flush with the wall beneath the retaining ring.

Accurate calculation of gage natural-frequency and sensitivity is quite complicated. Thin-plate formulas do not hold, and boundary conditions are not easily determined. Natural frequencies and sensitivities have been calculated using thin-plate formulas with the assumption of fixed edges. These calculated and experimentally-determined values are shown in Table 1.

TABLE 1—THEORETICAL vs EXPERIMENTAL VALUES OF SENSITIVITY AND NATURAL FREQUENCY

Gage Peak Pressure (psi)	Plate Thickness (inches)	Sensitivity (micromicrocoulombs/psi)		Lowest Natural Frequency (cycles per second)	
		Theoretical	Experimental	Theoretical	Experimental
3,000	0.05	0.46	0.618	140,000	94,000
10,000	0.09	0.142	0.225	250,000	125,000
25,000	0.13	0.068	0.130	360,000	90,000
50,000	0.19	0.032		520,000	76,000
100,000	0.25	0.018		700,000	79,000

* This gage sensitivity to side pressures—and consequently its limitation on frequency response—was not appreciated when this gage was first described at the Seventh National Instrument Conference. For further details see reference (h).

PRESSURE GAGE

P. L. EDWARDS
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White Oak, Maryland

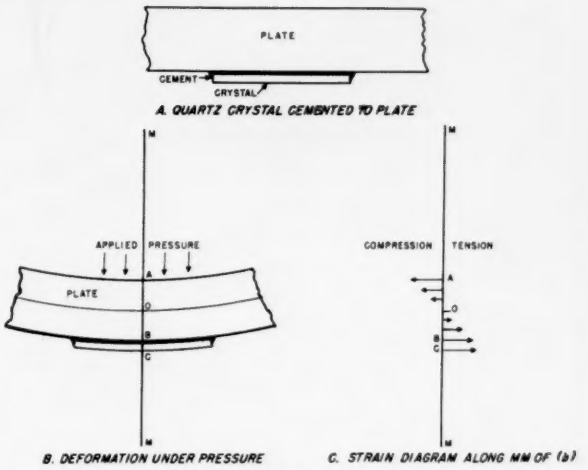


Fig. 1. Basic principle of pressure gage.

Theoretical and experimental sensitivities agree within a factor of 2, but natural frequencies do not. The gage sensitivities were calculated using formulas developed in reference (a), while natural frequencies were calculated from formulas in reference (b).

The fracture strain of quartz is given as 0.001 in reference (c). This is the design factor limiting the highest pressures that the gages will measure.

Gage Response

Pressure-time data derived from an analysis of compressor action determine frequency-response requirements for the pressure gage. In Fig. 4 these data are shown graphically with an analytical curve closely approximating the computed curve. The analytical approximation simplifies calculations. The approximate pulse, with its sharp corners, has more high-frequency components than the calculated pulse. Consequently, if the approximate pulse is not excessively distorted, then neither will be the expected pressure pulse.

The pressure gage is an electromechanical transducer, and as such has a relatively complicated frequency response, with many natural modes of oscillation. The complexity of the gage's response characteristics precludes the direct calculation of its distortion of the pressure pulse. It is necessary, therefore, to use a less direct approach. To determine expected gage distortion an equivalent second-order system was considered, consisting of a series resistance, inductance, and capacitance circuit. The input, across the three elements in series, is a voltage proportional to the approximate pressure pulse and the output is the voltage across the capacitor. Calculations indicate a maximum distortion of the pressure pulse of 6%. The calculations also show that the distortion introduced by the gage will be almost entirely oscillatory and at the gage's natural frequencies.

In order to determine the parameters to use in the "equivalent" electrical circuits, it is necessary to per-

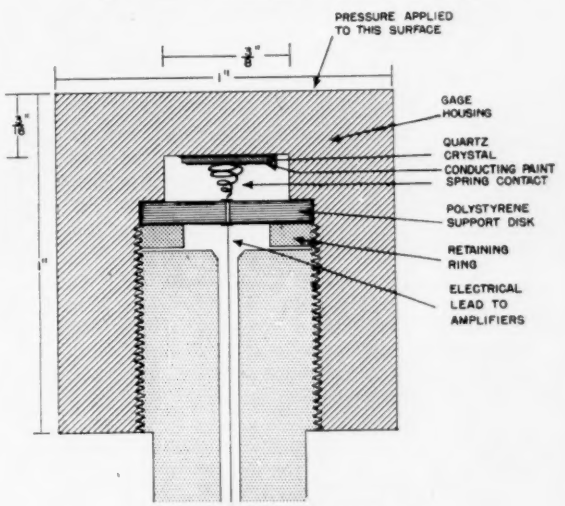


Fig. 2. Pressure gage.

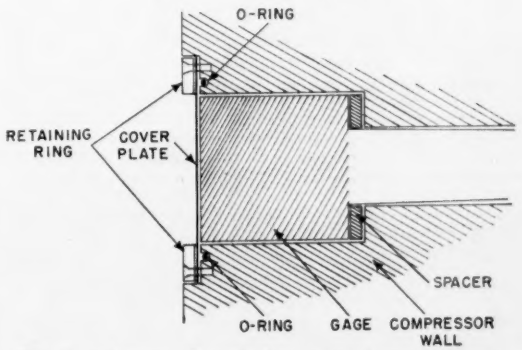
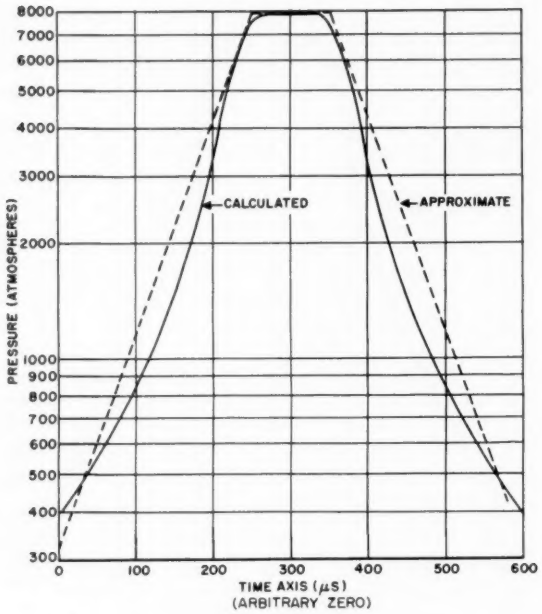


Fig. 3. Manner of mounting gage in compressor.



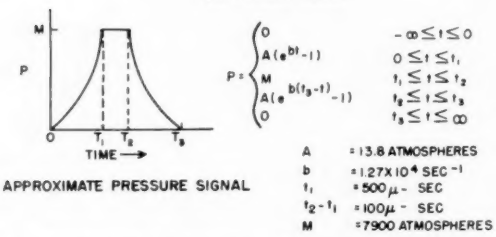

M
P
0
T_1
T_2
T_3
TIME
APPROXIMATE PRESSURE SIGNAL
$P = \begin{cases} 0 & -\infty \le t \le 0 \\ A(e^{bt}-1) & 0 \le t \le t_1 \\ M & t_1 \le t \le t_2 \\ A(e^{b(t_3-t)}-1) & t_2 \le t \le t_3 \\ 0 & t_3 \le t \le \infty \end{cases}$
A = 13.8 ATMOSPHERES
b = 1.27X10⁴ SEC⁻¹
t_1 = 500μ - SEC
$t_2 - t_1$ = 100μ - SEC
M = 7900 ATMOSPHERES

Fig. 4. Calculated pressure pulse and approximation.

form tests on the gage. The first, the "bouncing ball" test,* determines the lowest natural frequency of the gage. The second, the "bouncing rod" test,** determines the response of the gage to a unit step function, and from this its approximate bandwidth.

The bouncing rod data also give information concerning the low-frequency response of the gage. It had been thought that the crystal cement might show a relaxation phenomenon—i.e., the crystal might initially be stretched as predicted by theory, but that subsequently the cement would flow and thereby reduce the tension on the crystal. Experiments were performed with rods of contact time 0.7 millisecond, and no such relaxation was observed. Thus it is concluded either that such a relaxation phenomenon does not exist or that it occurs so slowly as not to be important in the pressure measurements.

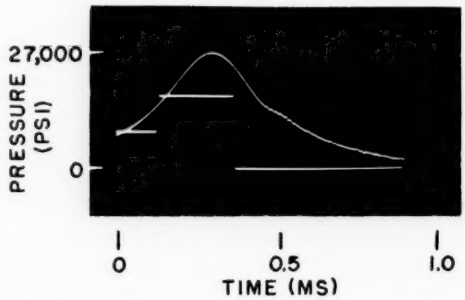


Fig. 5. Pressure during compressor run.

Gage Calibration

A gage can be calibrated by applying a known pressure step and observing gage output. First the gage is mounted in the pressure chamber. A pump builds up the pressure and the pressure balance (or a calibrated Bourdon gage) measures it. A valve is then closed to separate the pressure balance and pump from the rest of the circuit. The pressure is dumped and the gage output, displayed on an oscilloscope, recorded photographically. Knowing the pressure change, the oscillograph calibration and the capacitance across the gage, it is possible to calculate the charge sensitivity.

Fig. 5 shows a pressure record for a run with the adiabatic compressor. The peak pressure and time scale are indicated. There is no evidence of natural-frequency oscillations until after the peak pressure has passed; the oscillations which then occur are small and are apparently due to shocks transmitted from the compressor wall to the gage. The baseline is the same for the pressure signal and voltage calibration.

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g. Bobroff and Atanasoff, Naval Ordnance Laboratory Memorandum 5204, 1944.
h. Edwards, P. L., NavOrd 3963, "A High-Speed High-Pressure Gage: Part II," 1955.

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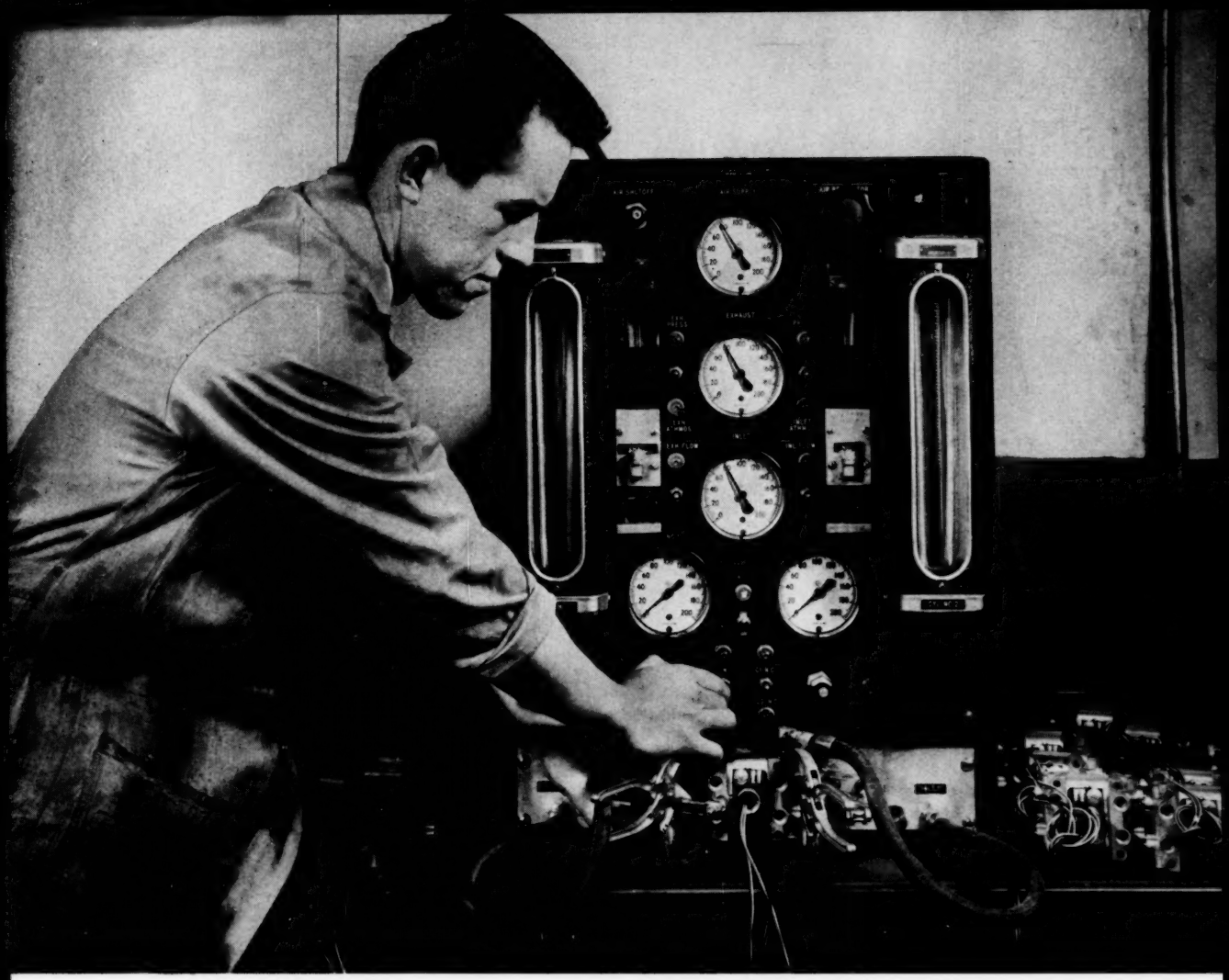
* The bouncing ball test consists in dropping small balls onto the face of the gage and recording the output. The ball striking the gage sets it into oscillation in its natural modes. It is from such records that experimental values of the lowest natural frequencies of Table 1 are determined. It is from similar records that the damping of the lowest frequency of vibration is calculated to be 2% of critical. The damping calculations are based on consideration of an equivalent linear second-order system with viscous damping.

**The "bouncing rod" test consists in bouncing a rod (6 inches long and ⅛ inch in diameter) on the face of the gage and recording the output. From the theory of bouncing rods, reference (e), the force exerted by a one-dimensional rod bouncing on a rigid surface is constant for the period of contact—the time it takes for sound to travel from one end of the rod to the other and back. Thus the bounce of the rod on the gage face is equivalent to the application of a positive step function followed a short time later by a negative step. The duration of the bounce was 60 microseconds. For a given series of tests, the rise time of the gage output varies from 3 to 8 microseconds, depending on the rod-to-gage-face contact. Assuming one is justified in using the approximate equation, sometimes used in amplifier design, reference (f):

$$t\,f = K$$

where t is the rise time, f is the bandwidth, and K is a constant between 0.35 and 0.45; then, from the rise time data, the equivalent bandwidth is of the order of 50,000 cps to 130,000 cps. These data are only approximate, but are of the order of magnitude that is expected from the bouncing ball data.

Circle 64 on inquiry card. ⟶



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Principles and Use of

ORIFICE-METER COEFFICIENTS

Orifice metering requires detailed knowledge of the meter coefficient, including calculation and correction factors. Of interest and importance are the history of development of the meter coefficient, and its special uses.

RUSSELL D. WOOD
Honolulu Oil Corp.

ORIFICE PRINCIPLE was known in ancient times. It was known, for example, that the volume of fluid that would pass through an orifice is constant for certain head pressures and, for this reason, the orifice was used for measuring time. The Romans are thought to have been well aware of the laws of fluid flow through orifices because orifices were extensively used to measure or limit water flow, and there existed a specification limiting the ratio of orifice size to line size.

One of the earliest known users of sharp-edged orifice plates in the U. S. A. was *E. W. Robinson*, a professor at Ohio State University, who used sharp-edged orifice plates in 1880, and orifice meters were used in the vicinity of Columbus, Ohio, for measuring natural gas about 1890.

A commercial installation of the sharp-edged orifice was made in 1908 by the Lone Star Gas Company, and by 1911 many gas companies were experimenting with orifice meters. An orifice meter was installed by the Hope Natural Gas Company of West Virginia in November 1911.

The Wichita Pipe Line Company ran tests at Joplin, Mo., where they used a gas holder as a basis of measurement.

Mr. Thomas Weymouth of the American Meter Company did some experimenting in 1913 and his work resulted in a set of *orifice constants*.

The Erie holder tests were made in 1915 by the Metric Metal Works of Erie, Pa., and were thought to confirm the Weymouth constants. About this time, orifice constants were submitted to gas-handling companies for use. Basic constants were published in Westcott's first edition of *Gas Measurement* in 1918, and these were generally used by the industry for many years.

Presented at 6th Annual Instrument Short Course, Los Angeles Harbor Junior College.

September Meeting: *Thursday, the 19th; Rio Hondo Country Club, Downey, Calif.*
Feature: *Aaron Waxman, Hagan Chemicals & Control Inc., will present a paper on "Water Control." Also a Panel Discussion of the I. S. A. Show highlights.*

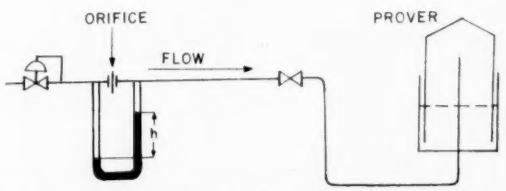

FIG. 1. EXPERIMENTAL METHOD for determining orifice constant.

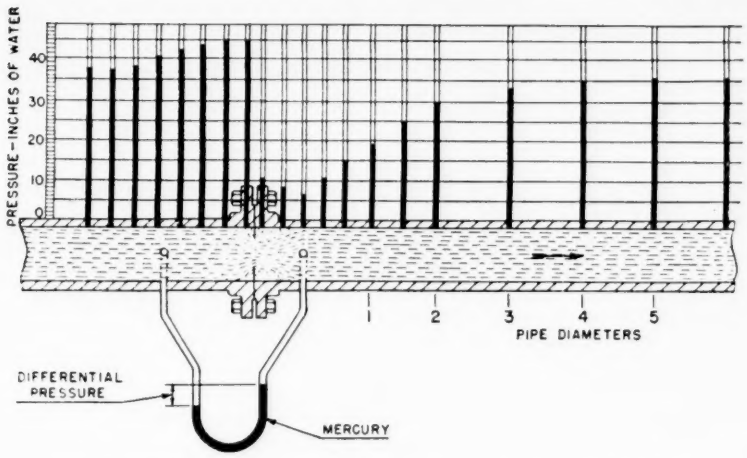

FIG. 2. **PRESSURE** across orifice depends on pressure-tap location.

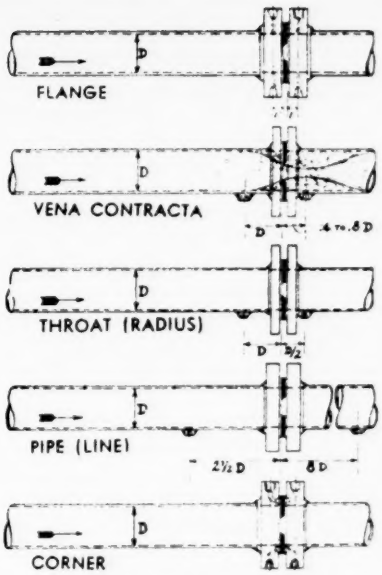

FIG. 3. **PRESSURE** taps.

An extensive series of tests were run in 1932-33 at the Ohio State University. These are considered to be the most extensive and reliable ever run, and are the basis of the present ASME-AGA constants. Work done in both England and Germany has corroborated the work done in the United States.

The principle of the pitot, long known, was thought of as possibly applying to the orifice. The fact that it does apply was demonstrated by the early experimenters in this country.

Flow Equations

The formulas for flow through any orifice in terms of the differential across that orifice are as follows:

For Gas or Steam:

$$Q_G = (C') \ (\sqrt{h}) \ (\sqrt{P_2})$$

For Liquid:

$$Q_L = (C') \ (\sqrt{h})$$

Where:

C' = a constant C times multipliers for correction of temperature, pressure, viscosity, etc.

Q_G = quantity of gas at standard conditions (14.7 psia and 60°F) flowing per hour, in *standard cubic feet/hour.*

Q_L = quantity of liquid (at flowing temperature) flowing per minute, in *U. S. gallons/minute.*

h = differential pressure across orifice (in *psi* or *inches of water,* as given in established tables).

P_2 = static downstream pressure in *psia.*

The Orifice Constant C

Note that the basic flow equations have a constant C':

C' = C times multipliers

The symbol C represents the flow for unity differential-pressure. This symbol in the orifice formula is based on experimental data; a great deal of time and effort has been spent on it. Tables of constants are printed in handbooks for gases and vapors, for liquids, and for steam.

Example of Use of Orifice Constant

Let us consider a 1″ orifice in a 4″ orifice tube. the meter having flange-tap outlets. The line fluid is a gas.

The orifice constant (from the proper *SCMA Handbook* table) is given as 202.0

This number is in itself a volume of gas in standard *cubic feet per hour.* (Note: An orifice constant for liquid is a volume of liquid expressed in *gallons per hour*; an orifice constant for steam is a volume of steam expressed in *pounds per hour.*)

The value 202.0 found in the table refers only to the orifice size and pipe size stated. That is, the constant 202.0 is the volume of gas in standard cubic feet that will pass through this particular orifice per hour when concentrically placed in a 4″ orifice tube when (1) the differential pressure remains constant at 1″ water, and (2) the static pressure downstream remains constant at 1 psia. It must be stated further that the gas is of 1.00 specific gravity and the temperature 60° Fahr.

For liquid, the constant is defined in similar terms. Briefly, the orifice constant is the volume of liquid in gallons that will pass through the given orifice in one hour when the differential remains constant at 1″ water. As the static pressure has little effect in determining the volume in liquid flow, it is not included in the formula for liquid flow.

Orifice Constants Determined By Experimental Means

The first method of determining an orifice constant was necessarily experimental, as shown in Fig. 1.

Assume that a 1" orifice is installed in a 4" line. A reducing regulator may be set to hold a constant pressure on the meter tube as gas flows into a measuring device. Assume the gas to have specific gravity of 1.00 and to be at 60°F. Also, assume no deviation from the gas laws.

The following tests are then made:

The pressure is held constant and the differential is increased through successive steps, as shown in Table 1.

Table 1—Test of 1" x 4" Orifice

Diff. (Inches Water)	Press. (Pounds Absolute)	Q (Cubic Feet/ Hour)	$\sqrt{h}$	$\sqrt{P}$	"C" $Q/\sqrt{hP}$
1	16	808	1	4	202
4	16	1,616	2	4	202
9	16	2,424	3	4	202
16	16	3,232	4	4	202

The same constant (202) will be obtained if the pressure is increased and the differential held constant, as shown in Table 2.

Table 2—Test of 1" x 4" Orifice

Diff. (Inches Water)	Press. (Pounds Absolute)	Q (Cubic Feet/ Hour)	$\sqrt{h}$	$\sqrt{P}$	"C" $Q/\sqrt{hP}$
4	16	1,616	2	4	202
4	64	3,232	2	8	202
4	144	4,848	2	12	202
4	256	6,464	2	16	202

In each case of Tables 1 and 2, the quantity divided by the square root of the product (differential times the absolute pressure) is equal to the constant, 202. This number is therefore known as the hourly orifice constant C for a 1" orifice in a 4" pipe.

Correction Factors

The calibrating gas has been assumed to be at a specific gravity of 1.00 and at a temperature of 60° F. However, the calibrating gas may be of any density and temperature and the gas laws would, of course, apply. As many of the following correction factors as apply should be used:

$$C = Q/(\sqrt{h})\ (\sqrt{P_2})\ (F_{e2})\ (F_R)\ (F_{PV})\ (F_G)\ (F_T)$$

where Q is the quantity of gas in cubic feet at 14.73 psia and 60° F determined by some independent means.

F_{e2} is expansion factor correction when P_2 is used.
F_R is Reynolds Number factor correction for viscosity
F_{PV} is superexpansibility factor correction
F_G is specific-gravity factor correction
F_T is temperature factor correction

All these factors (except Q) are determined at the orifice.

It must be remembered that the so-called orifice constant holds constant only within certain limits of the *beta ratio*—i.e., the diameter of the orifice divided by the diameter of the pipe. These limits are fairly accurately defined for gas. They are probably not as accurately defined or as reliable for liquid. Some of our differences in metering liquid may be because of this reason.

Comparison of Early and Present Orifice Constants

Constants have changed as calibration methods became more precise. Table 3 shows this evolutionary development.

Table 3—Constants of 1915 vs 1957

Orifice and Pipe *	Constant of about 1915		Constant of A.G.A. Report #3	Early Constant % Higher Than Now
	Press. Base		Press. Base	
Taps	14.4	14.73	14.73	
1" x 4"	219.2	214.3	209.91	2.1
2" x 6"	904.1	883.8	870.93	1.5
3" x 8"	2,078.8	2,032.2	2,007.3	1.2
4" x 10"	3,742.9	3,659.0	3,616.0	1.2

* 2½ and 8 diameter connections

Change of Base

There commonly occur adjustments of the orifice constant which we call a *change in base.* This refers only to the weight of the cubic-foot unit of measurement.

There seems to have been in the past a concept, other than we now have, in regard to the relation of pressure base and barometric pressure. The barometric pressure was more or less standardized and the pressure base became a variable.

The concept of the pressure base was probably inherited from the concept of displacement metering because the displacement meter shows cubic feet *at the existing pressure in the main.* Thus pressure base was established as the combination of two pressures—first, the barometric pressure and second, line pressure, such as 4 ounces; the sum then was used as the pressure base, establishing the size of the cubic-foot unit.

Different size cubic-foot units came to be used in various gas measuring localities. This condition is similar to a farm community using a bushel measure of its own choosing.

The measurement of gas in a closed pipeline is concerned with the barometric pressure only indirectly; it is concerned only because the Bourdon tube used commonly as a means of obtaining the absolute pressure in the pipe is affected by changes in barometric pressure. Originally, the necessary adjustment for baro-

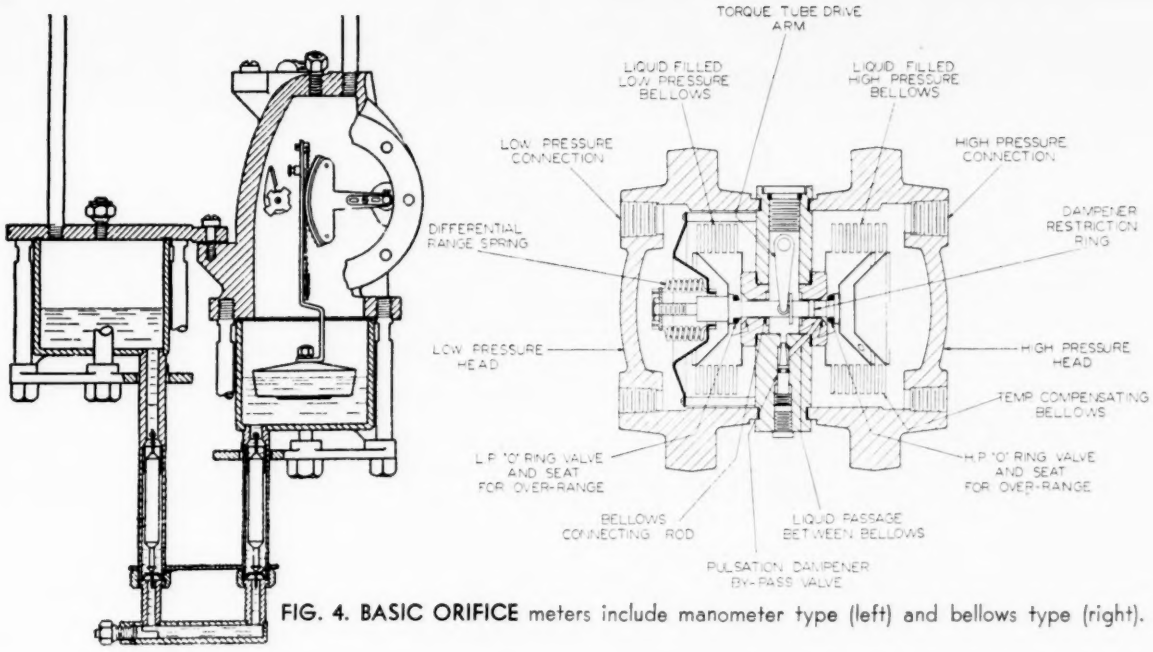
TORQUE TUBE DRIVE ARM
LIQUID FILLED LOW PRESSURE BELLOWS
LIQUID FILLED HIGH PRESSURE BELLOWS
LOW PRESSURE CONNECTION
HIGH PRESSURE CONNECTION
DIFFERENTIAL RANGE SPRING
DAMPENER RESTRICTION RING
LOW PRESSURE HEAD
HIGH PRESSURE HEAD
TEMP. COMPENSATING BELLOWS
L.P. 'O' RING VALVE AND SEAT FOR OVER-RANGE
H.P. 'O' RING VALVE AND SEAT FOR OVER-RANGE
BELLOWS CONNECTING ROD
LIQUID PASSAGE BETWEEN BELLOWS
PULSATION DAMPENER BY-PASS VALVE

FIG. 4. BASIC ORIFICE meters include manometer type (left) and bellows type (right).

metric pressure was done by the so-called "gage extension"—that is, the extension of the coefficient or unit volume to the actual existing volume:

$$\text{Extension} = \sqrt{(\text{diff. press.})\ (\text{abs. press.})}$$
$$= \sqrt{(\text{h})\ (\text{p} + \text{barometric press.})}$$

At present, the adjustment for barometric pressure is usually accomplished on the meter chart. For example, the static pen, at rest, is set to a point on the chart corresponding to barometric pressure at the locality so that the sum (p + barometric press) would then be indicated at all times.

In terms of weight, the cubic-foot unit may be made greater or smaller by virtue of pressure change, temperature change, or gas density change.

Pressure Factor: The factor that changes the base for pressure is *(psia of unit)/(new psia)*.

Temperature factor: This factor is *(new absolute temperature/absolute temperature of unit)*.

Specific Gravity Factor: This factor is *(specific gravity of unit/ new specific gravity)*.

In event of pressure and temperature adjustments, more or less gas will be said to flow through an orifice in direct proportion to the size of the cubic foot unit selected—i.e., if the cubic foot unit is twice the size, half the number will be involved, and vice versa.

In specific-gravity adjustment, an adjustment of base implies a change to a unit of different density, and in an orifice meter this involves the differential because as soon as a change is made in the density of a fluid flowing through an orifice it affects the pressure it requires to force the fluid through.

The relationship of differential and specific gravity is:

$$\text{h} = 1/\text{sp.gr.}$$
$$\text{C} = \sqrt{\text{h}} = \sqrt{1/\text{sp. gr.}}$$

Thus an increase in density reduces flow.

As the differential of an orifice gage is sensitive to density change of the flowing fluid, *an orifice meter is a weight-measuring device.*

It is interesting to note that the reading of a displacement meter is *not* sensitive to the density of the flowing fluid. If the density of fluid flowing through a displacement meter increases, this would increase pressure drop or decrease the volume through a displacement meter, but the meter dial would continue to indicate the cubic feet of fluid flowing regardless of density change.

From this fact stems the statement that a *displacement meter is a volume-measuring device.*

Calculation of Orifice Constant

An orifice constant (C) is calculated in the following way:

$$\text{C} = (\text{A})\,(\text{V})\,(\text{C}_\text{v})$$

where A is area of orifice in sq ft $= 3.14\ \text{d}^2/4$; d is orifice diameter; V is theoretical velocity in ft/sec of gas passing through orifice $= \sqrt{2\text{gh}}$; C_v = ratio of actual to theoretical flow, as determined experimentally or from tables.

Using the area of orifice in square feet, converting h to feet, converting V to feet per hour, etc. (in other words, using the proper and same units in all cases), C becomes:

$$\text{C} = 338.2\ \text{d}^2\ \text{C}_\text{v}$$

The term $338.2\ \text{d}^2$ is known as the *theoretical base volume* or *theoretical base coefficient,* or theoretical *hourly air coefficient* (see SCMA Data Sheet 153). It is the cubic feet of gas that theoretically pass

through an orifice hourly at unity pressure drop (1" of water) when orifice has unity coefficient of discharge (C_v).

There are five approximations involved in the development of the above formula; in general, it can be said that it applies only to a perfect gas.

C_v and K_o

It is necessary now to apply the actual-to-theoretical ratio. Formulas have been developed for orifices with flange and line taps. For flange connections:

$$C_v = 0.606 + 1.25\ (\beta - 0.41)^2$$

With C_v available, the working orifice constant is:

$$C = 338.2 C_v\ d^2$$

More complicated empirical equations developed later to better represent experimental data changed the actual-to-theoretical ratio to that now known by the symbol K_o, a term that includes the velocity-of-approach factor:

$$C = 338.2\ K_o\ d^2$$

A formula for K_o has been developed, and tables have been developed for flange taps. The tables make the determination of an orifice constant a simple procedure regardless of the size of the orifice and pipe.

Example

For example, let us consider again the 1" x 4" meter: $\beta = 0.249$; $K_o = 0.597323$.

$$C = 338.2\ K_o\ d^2$$
$$= 202.0$$

Note that 338.2 is a theoretical volume; 202.0 is an actual volume.

The differences in orifice constants from early days to the present are due to changes in the C_v or K_o factors. These factors represent the efficiency of an orifice. The 1" x 4" orifice, for example, first reported to be 63.3% efficient ($C_v = 0.633$) was found to be only 59.7% efficient ($K_o = 0.597$).

C.N.G.A. Method

When tabulated values of K_o are not available, as for odd-sized orifices or odd-sized tubes, then a method developed by C.N.G.A. can be applied, as follows:

$$C = Z\ L\ d^2$$

where $Z = 338.2\ K_{o4}$, $K_{o4} = K_o$ for a 4" tube; L = ratio of unknown K_o to the known K_{o4}. Tables of Z and L are available.

Relation of Gas and Liquid Constants

If given the gas constant of an orifice, how can we obtain the liquid constant of that orifice?

From the basic flow equations, we have seen that the theoretical hourly air coefficient is 338.2; this means that 338.2 standard cubic feet of gas will pass hourly through the 1" orifice—if the C_V is unity, if pressure drop is unity, etc.

Similarly, it is known that 340.1 gallons per hour will flow through a 1" orifice—if pressure drop is unity, K_O is unity, specific gravity is unity, etc. Hence

$$\text{Liquid constant} = (\text{gas constant})\,(340.1/338.2)$$
$$= (\text{gas constant})\,(1.0056).$$

This same factor can be derived by the process of *change of base, as follows*:

As the published gas coefficient implies flow at 1 psia, it is first necessary to obtain the gas flow at atmospheric pressure. This is done by multiplying by $\sqrt{14.73}$.

To convert the density of the gas of 1.00 specific gravity (0.076507 pounds per cubic foot) to density of liquid in pounds per cubic foot, multiply by the factor

$$(0.076507/62.3668)$$

because 0.076507 is weight of 1 cu ft of air at standard conditions; 62.3668 is weight of 1 cu ft of water.

The change in units used in the gas and liquid formulas require the factor (1728/231).

The product of these three factors is 1.0056.

Special Uses For Orifice Constants

Determination of Permanent Pressure Loss

For a pipe-tap meter the differential pressure is the permanent pressure loss. Thus, for flange taps, find the pipe-tap differential as follows:

Given: A 4" flange-connected orifice meter.

Required: To determine the unrecovered pressure loss through a 1" orifice installed in this meter.

A. The differential pressure existing at the point of pipe-tap outlets can be considered the unrecovered loss; therefore, the problem resolves into the determination of the differential at the pipe outlets when 1" of water exists at the flange outlets.

B. The orifice constant for flange taps is 202.0 and the orifice constant for pipe taps is 209.9.

C. From: $V = C\sqrt{h}$
$h = V^2/C^2$

where h = differential at pipe outlets; C = coefficient for pipe outlets; and V = 202 (when 1" drop exists at flange taps). Substituting: $h = (202/209.9)^2 = 0.93$. Therefore, the permanent pressure loss is 93% of the differential indicated at the flange.

Coefficients as Applied to Orifice Capacities

Orifice constants can be extended to serve as the basis for capacity tables.

Again, in case of the 1" orifice in a 4" line:

Orifice constant times the square root of 10% of the differential range can be taken as the proper minimum rate for this orifice. Also:

Orifice constant times the square root of 90% of the differential range can be taken as the proper maximum rate for the orifice plate.

Maximum rate will then be exactly 3 times the minimum rate. Multiplier tables or factors can be used for changes in orifice-gage range or pressure to make a practical capacity table or curve. The proper amount that an orifice will handle then can be determined at a glance.

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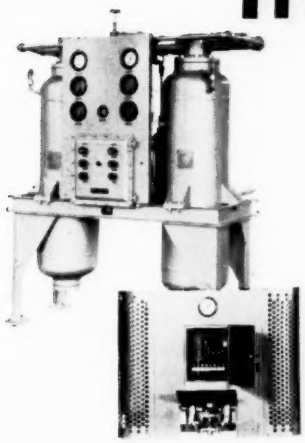

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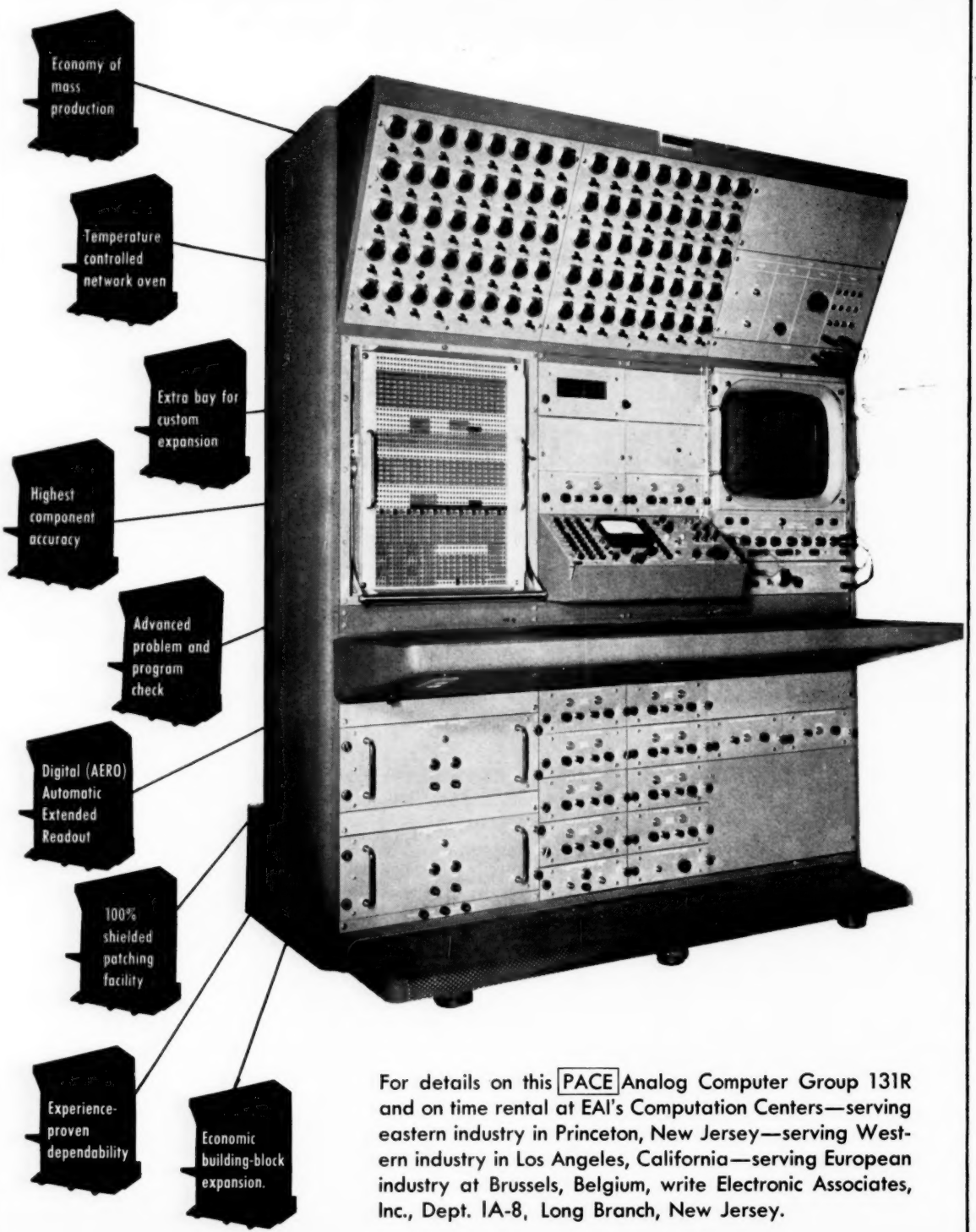

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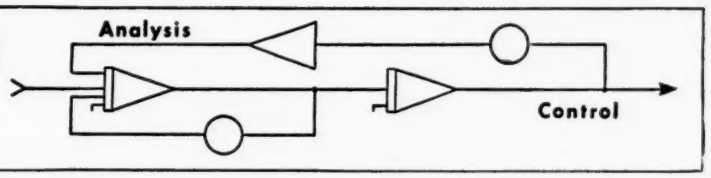

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Bits

Different kind of Newsletter this month—almost formal. Reason is that your Editor, who approaches all mathematics somewhat timorously, is downright frightened by partial differential equations. I therefore asked each of the three speakers on that subject at the May meeting of the Western Simulation Council to give me a writeup of what they said (or wished they had said), and I pass these on to you under Pieces with a minimum of editing.

Pieces

WESTERN S/C MEETING OF 16 MAY ON "PARTIAL DIFFERENTIAL EQUATIONS"

More than 85 representatives of about 35 organizations met at Convair (Pomona, Calif.) on 16 May to discuss machine solution of partial differential equations.

Kovach on Analog Computer Solutions

L. D. Kovach (Douglas Aircraft Co., El Segundo, Calif.) began his talk on "Solution of Partial Differential Equations on an Active Electronic Analog Computer" with a reference to one of our definitions of an Expert: "I had an unnerving experience driving up here this morning from El Segundo," he said, "I was keeping track of the mileage quite closely and when I got here, I noticed that I was exactly 47.2 miles from home. You can imagine my consternation if you recall the definition of an expert as a person more than 50 miles from home."

"At Douglas, El Segundo, we have an analog computer of the direct analogy type," Dr. Kovach continued. "The computer consists of 260 passive elements and approximately 85 amplifiers. The passive elements are of four kinds: resistors, capacitors, inductors, and transformers. Since the inductors and transformers do not like to look at dc or at low frequencies, we are forced to work at frequencies greater than 50 cps. Because we are working at such high frequencies I actually do not belong at a Simulation Council meeting.*

*Wrong! Everyone who can stimulate the flow of information in our field by disseminating or absorbing knowledge, or simply by asking questions (not necessarily intelligent ones) belongs at a Simulation Council meeting.—Ed.

However, I feel that I may be able to contribute something helpful on this afternoon's subject. Some of our passive elements are quite expensive. For example, our inductors must not have any resistance. Actually they have a small amount of resistance, about 10 ohms or so. Moreover, the capacitance between windings must be kept to an absolute minimum. To manufacture an inductor of this type with a number of taps to obtain various values of inductance is quite expensive. An inductor costs in the neighborhood of 1.2 kilobucks. Our transformers are also complex and expensive.

"The resistors and capacitors, on the other hand, are relatively inexpensive and of the variety that every computer laboratory has in stock. This is extremely fortunate because these elements are required to make a finite difference analogy to a partial differential equation. For example, consider the second-order partial differential equation

$$\nabla^2 \Phi = k \frac{\partial \Phi}{\partial t}$$

The region over which this equation is to be solved is covered with a network of resistors and capacitors. One point of this region or one node of the network would look like Fig. 1 in the two-dimensional case:

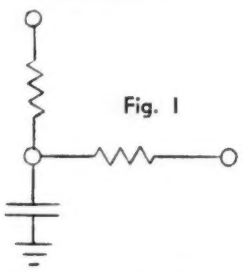


Fig. 1

The capacitor is proportional to k, and the other ends of the resistors are connected to other nodes of the network. The values of the resistors are proportional to the distances between nodes. If the equation were modified by the addition of another term—for example,

$$\nabla^2\Phi = k\frac{\partial\Phi}{\partial t} + f(t)$$

we would insert a current i, which is proportional to f(t), into the proper node.

"The currents which must be supplied to the network have come in the past from a current generator. This is a device similar to a dc amplifier except that it is connected to a floating power supply. The output of this current generator is a current proportional to the input voltage. This is a special device and therefore has not been widely used.

"Now however there has been developed a device known as a *Type 2 Current Generator,* a product of the Analog Computing Group at Lockheed Aircraft Corporation, Burbank. It can be made from two ordinary operational amplifiers as shown in Fig. 2.

"You will note from the equations that the current output of this device is independent of the load resistance R_L. When e_o is fed back, it is fed into an adjustable resistor so that the gain of the device can be made exactly one. Under this condition the output impedance of the current generator is infinite. With the aid of this adjustable resistor the output impedance can be made negative also. If the output impedance is infinite, then the current at the output will be independent of the load. It should also be mentioned that if the negative of e_i is available, it can be summed into the second amplifier instead of the first. The value of R_F is somewhere between 100 and 1000 ohms and establishes the scale factor between voltage and current.

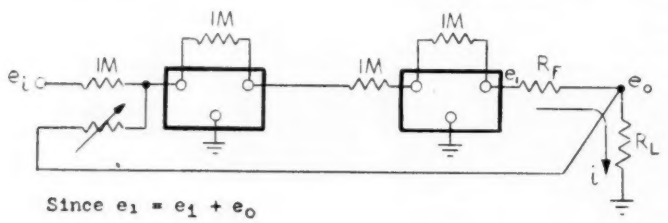
"By using current generators of this type and boxes of decade resistors and capacitors, it is possible to solve a variety of partial differential equations. If steady-state solutions only are sought, then the network need consist of resistors alone. If a transient problem is to be solved, then capacitors must be added to the network.

"There are several advantages to solving partial differential equations in this manner. Service and maintenance difficulties with a network of resistors and capacitors are at a minimum. Hardly anything can go wrong with a resistor or a capacitor. The Type 2 Current Generator is not a critical item. The use of a network to cover the region over which the equations are to be solved enables us to use the powerful relaxation method of Southwell.* We are able to represent irregular boundaries and a variety of boundary conditions. If the temperature along a boundary is constant, we keep the voltage along the corresponding part of the network constant. If the temperature along a boundary varies as a function of time we use function generators to produce the voltage which is the required function of time. If one region is of more interest than another, it is possible to cover this region with a finer net.

"This method has been in use for a number of years. Two references come to mind which might help those who wish to study the details further: James H. Green. Jr. and Victor B. Corey; The Analog Solution of Simultaneous Partial Differential Equations by Means of Passive and Active Electrical Networks. Frederic Flader, Inc.; Report, 1947.

G. D. McCann and C. H. Wilts; Application of Electric Analog Computers to Heat-Transfer and Fluid-Flow Problems. *J. Appl. Mech.*, vol. 16, No. 3, Sept. 1949. pp. 247-258."

*A rival to Relaxacisor and Slenderella? —Your Secy.



Since $e_1 = e_1 + e_o$

and $e_1 - e_o = 1\ R_F$

$\therefore\ e_1 = 1\ R_F$

or $1 = \frac{e_1}{R_F}$

Fig. 2

Paine on Solutions of Partial Differential Equations at Convair

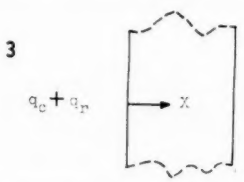
Steve Paine (Convair-San Diego), the next speaker, subsequently gave your Editor the following writeup, commenting "Anyway. this is what I intended to say."

"The purpose of my talk today is to explain informally four phases of Convair's activities in the field of partial differential equations, and to outline what we consider some of our most pressing needs for new methods of solution. These four phases are: current problems being solved; improved analog equipment; new partial D.E. Computers; improved methods of approximation.

Current Problems

"To illustrate the first phase, current problems, I'd like to cite the work of *David Otis* (Convair-San Diego). His problem concerned the simulation of nonlinear heat flow in a slab (Fig. 3), with no heat sources,

Fig. 3



or inputs. The equation to be solved was the heat conductor equation in rectangular coordinates for one-dimensional heat flow.

$$(1)\quad \frac{\partial T}{\partial t} = \frac{1}{\rho c_k}\ \frac{\partial}{\partial (x)}\left(K\frac{\partial T}{\partial x}\right)$$

q_c = convective heat flux, q_r = radiation heat flux, T = temperature, t = time, ρ = density, K = thermal conductivity, C_p = sp. ht. ρ, K, and C_p are all functions of temperature, T. The electrical analogy suggested was a special case of the Telegraph Equation where C and R are functions of E and S is distance.

$$(2)\quad \frac{\partial E}{\partial t} = \frac{1}{C}\frac{\partial}{\partial S}\left(\frac{1}{R}\frac{\partial E}{\partial S}\right)$$

Equations 1 and 2 are identical in form where electrical capacitance and resistance vary in the same manner as thermal capacitance and resistance.

"However, for most electrical analogies it's not convenient to vary resistance and capacitance simultaneously. If we hold C constant we have the modified electrical equation

$$(3)\quad \frac{\partial E}{\partial t} = \frac{\partial}{\partial S}\left(\frac{1}{RC}\frac{\partial E}{\partial S}\right)$$

If we perform a transformation on the thermal equation (1) by substituting

$$(4)\quad G = \int_{T_o}^{T} \frac{T\rho C_p}{\rho_o C_{p_o}}\, dT$$

ρ_o and C_{p_o} are the initial values of ρ and C_p at T_o: equation (1) becomes

$$(5)\quad \frac{\partial G}{\partial t} = \frac{\partial}{\partial X}\left(\frac{K}{\rho C_p}\frac{\partial G}{\partial X}\right) = \frac{\partial}{\partial X}\left(\alpha \frac{\partial G}{\partial X}\right).$$

where $\alpha = K/\rho C_p$

Now equations (3) and (5) are identical and we can proceed to solve the problem by the method of 'lumped parameters'.

"The idealized electrical circuit for equation (2) is shown in Figure 4, where E_c = voltage which simulates heat convection and E_R = voltage which simulates heat radiation.

Fig. 5 is the lumped-parameter analog of the ideal circuit.

But this circuit does not provide for variable resistance and therefore variable loading. Figure 6 shows two cells of Figure 5. The capacitance, C, rather than being connected to the reference ground, is connected to the grid of a dc amplifier, which is effectively at ground potential (within a few millivolts). The use of the amplifier provides a means for obtaining the value of E_R for computing purposes without any loading on the lumped parameter circuit. The voltage appearing at the output of the amplifier is fed to function generators A and B. Function generator

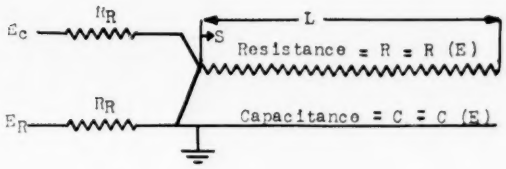


Fig. 4. Idealized electrical circuit.

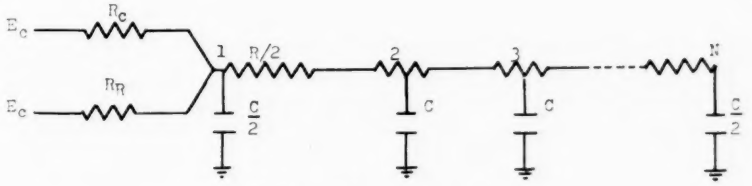


Fig. 5. Lumped-parameter circuit.

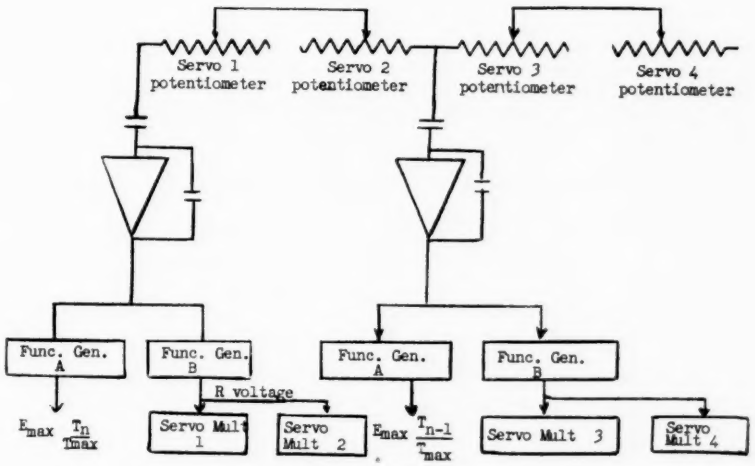


Fig. 6. Two cells of Fig. 5.

A satisfies equation (4) and supplies the temperature corresponding to the output E_n (the n^{th} cell). This output, for n = 1 at X = 0 is used to compute E_c and E_R boundary conditions. Function generator B satisfies the equation

$$R = \frac{\tau_{max} L^4}{t_{max} b^2 (n-1)^4 \alpha C}$$

where L = length of electrical resistance, n = number of cells, b = thickness of slab, $\alpha = K/C_p$

This provides a voltage proportional to R. This voltage is supplied to the servo-multiplier, which in turn drives the servo resistor (potentiometer) to the proper position.

"A comparison of the analog solution with a hand calculator solution was within 3%, which is sufficient for our present needs.

Improved Analog Equipment

"In this phase of our work we are improving the stability of amplifiers. Our hope is that, if the phase and stability of active elements can be improved enough, we can develop the same type of analogy that is now carried out on the direct passive-element analog computers for such problems as static and dynamic structures. In the case of structures with two-boundary conditions, only amplifiers and multipliers will be used. Therefore we will be concerned only with voltages and not with a mixture of voltages and currents. A hybrid computer of this kind is under design at Convair-San Diego.

A New Partial Differential Equation Computer

"The Astronautics Division of Convair has under development a

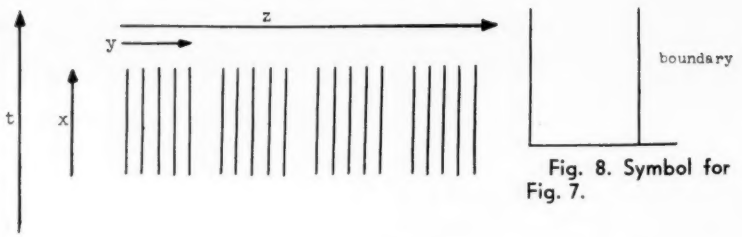


Fig. 8. Symbol for Fig. 7.

Fig. 7. Frame of memory rasters.

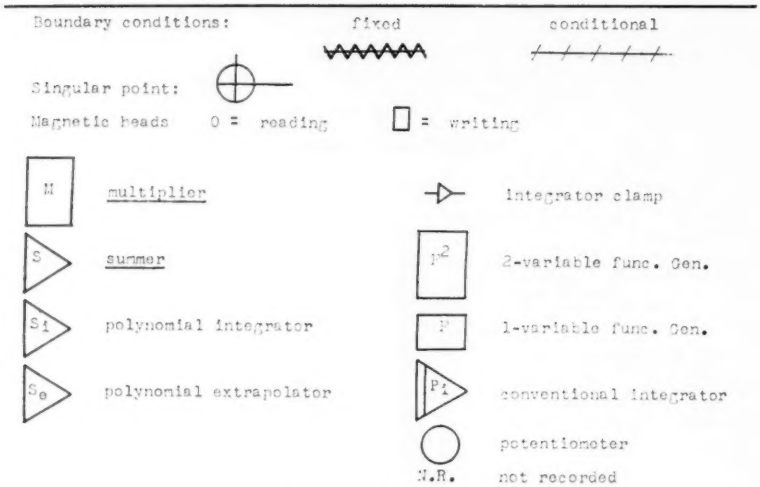


Fig. 9. Other symbols for AESOP.

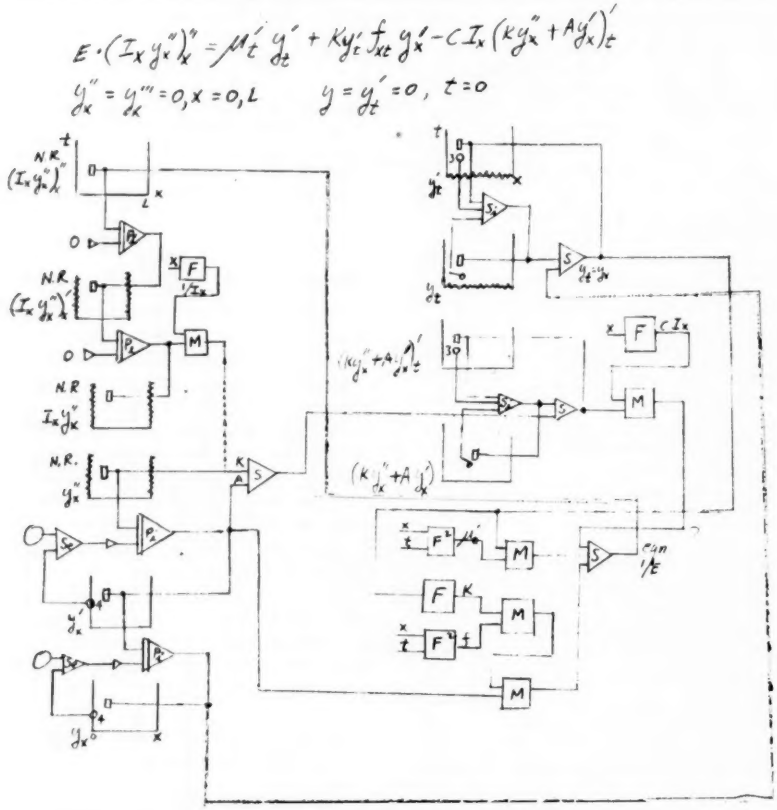


Fig. 10. Typical vibration problem.

special-purpose Partial D.E. Computer called AESOP, designed with *Dr. Lawrence Wainwright* as consultant. The computer performs continuous integration with respect to time with analog amplifier integrators, while performing simultaneous integration with respect to other independent variables by numerical integration. The continuous integration with respect to time is straightforward, but the integration with respect to any other independent variable requires a memory. The memory provides a means of integration by polynomial approximation, a technique familiar to digital computer people and one which can be found in books on numerical analysis.

"The memory consists of a set of rasters (sets of lines of fixed length). A group of rasters for, say, t_i is referred to as a frame. Figure 7 represents a frame of rasters. When a tape memory is used a line is a segment of a recording track.

A simplified symbol for Figure 7, useful in setting up the "flow diagram" of a problem, is shown in Figure 8. Other symbols are shown in Figure 9.

The following mathematical notation will be used in a sample problem to illustrate Dr. Wainwright's computer (Fig. 10):

$$(U_x')_{y'} = \frac{\partial}{\partial y}\left(\frac{\partial U}{\partial x}\right)$$

Improved Approximations

"The fourth phase of our activities is concerned with studies of improved methods of approximation.

"Dr. Albert Jackson of Cornell University, a consultant to Convair-San Diego, has made a study of methods of solving Partial D.E.'s. One of his conclusions is that in using hexagonal grid meshes in the application of relaxation methods to Partial D.E.'s on analog computers, one will use nearly three times as many resistors as will be used in a rectangular grid mesh. For example: in a 21-point rectangular grid, 42 amplifiers, 42 potentiometers, and 105 resistors would be needed. To cover a comparable area with a hexagonal mesh would require 52 amplifiers, 52 potentiometers, and 273 resistors. On Convair's existing equipment this is prohibitive.

"Another problem we are faced with is the stability of difference equations. Following the work outlined by R. D. Richtmyer and the late John von Neumann, we are investigating the reduction of grid size

in certain problems involving difference systems. For example, in some cases holding $\frac{\Delta t}{\Delta x}$ fixed while Δt and $\Delta x \to 0$, change will lead to an unstable system, while if we hold $\frac{\Delta t}{(\Delta t)^2}$ constant, the system will always be stable. R. D. Richtmyer has given an excellent discussion of this problem in a paper presented at the June 1954 meeting of the ACM at Ann Arbor Michigan."

Stark on Analog Computer Solutions

Following Steve's talk *Bill Stark* (Convair, Pomona, Calif.) presented his "Solution of Partial Differential Equations on an Active Analog Computer," the text of which follows.

"One of the problems considered in the Computer Laboratory at Convair-Pomona during the past year is the solution of partial differential equations on a differential analyzer. At present we are trying to develop a method for studying wing flutter, a self-excited unstable motion* brought about by aerodynamic forces as well as forces arising from the motion of the wing.

"Since the deflection and rotation of a wing are functions of distance along the span as well as time, these motions are described by a pair of partial differential equations. Various methods have been devised for reducing the partial differential equations to allow the use of a differential analyzer. At least two of these techniques, modal analysis and finite difference approximation, have been used at Project Cyclone[a, b].

"Modal analysis, as used at Project Cyclone[a], assures that deflection $h(l, t)$ and rotation $\alpha(l, t)$ can be approximated by

$$h(l, t) = \sum_{k=1}^{n} h_k(l)\, q_k(t)$$

and

$$\alpha(l, t) = \sum_{k=1}^{n} \alpha_k(l)\, q_k(t)$$

In these expressions $h_k(1)$ and $\alpha_k(1)$ are deflection and rotation, respectively, for the k^{th} coupled mode, and $q_k(t)$ is a dimensionless function of time. These approximations permit the motion of the wing to be described by n second-order ordinary differential equations for the $q_k(t)$ functions. It is assumed that a small number of modes ($n = 3$ or $n = 4$) will give a fairly accurate solution.

*Elvis?

Fig. 11. Representation of mass M and spring K.

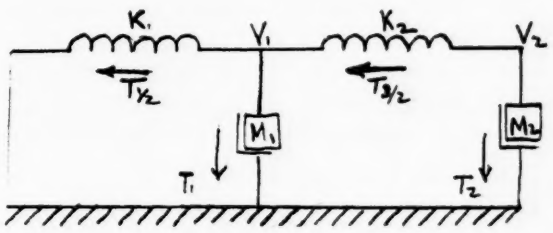


Fig. 12. Lumped-constant representation of torsion bar.

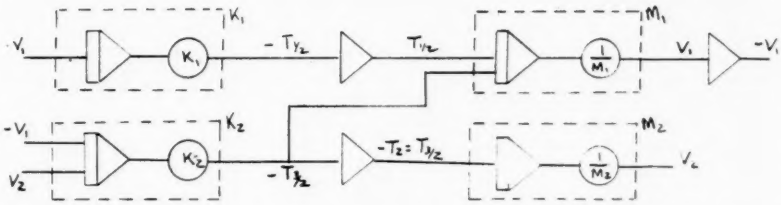


Fig. 13. Differential analyzer circuit for lumped-constant mechanical system.

The stability of the dimensionless time function is studied on the differential analyzer.

"The finite difference approximation consists of first dividing the wing into a number of rigid sections connected by springs. The motions of each section can then be described by two ordinary differential equations, one for deflection and a second for rotation.

"A finite difference approximation is considerably more flexible than a modal analysis. For example, a finite difference approximation permits the rapid change of mass distribution since mass, static moment, and moment of inertia appear explicitly in the differential equations whereas with modal analysis, changing mass distribution generally means calculating new modes.

"At Convair-Pomona we have been making two more or less parallel approaches to simulating a wing structure, employing finite difference approximations in each case. The first approach is based on the work of *Dr. R. M. Howe* (Dept. of Aeronautical Engineering, University of Michigan, Ann Arbor, Mich.).[c] Bob Howe considers pure bending only, but we have attempted to extend his method to include coupling between bending and torsion. The wing is broken up into a number of sections. Lumped inertia terms and spring constants are obtained for each section, and derivatives with respect to the span-wise coordinate are approximated by finite differences. The motion of the wing can then be approximately described by two ordinary differential equations for each of the wing sections.

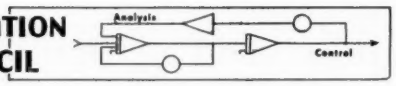
"Our second approach to simulating a wing structure is based on an article by *V. L. Larrowe*, also of the University of Michigan[d]. Larrowe attempts to use elements of a differential analyzer to simulate a mechanical system in a manner similar to that in which passive elements are used. That is, he uses a differential analyzer in a form of direct simulation.

"Larrowe's representation for a mass M and a spring having a constant K are shown in Fig. 11. A lumped-constant representation for a torsion bar clamped at one end is shown in Fig. 12.

Application of Larrowe's method of direct simulation to the lumped constant mechanical system results in the differential analyzer circuit shown in Fig. 13.

This method can be extended to represent a wing with coupling between bending and torsion.

"We intend to use a supersonic aerodynamic simulation devised by Wilts[e]. This method involves the multiplication of α, $\dot{\alpha}$, and $\dot{h}$ for each



wing section by an appropriate transfer function to generate aerodynamic lifts and moments. For example, one of the lift terms is proportional to

$$\left(\alpha - \frac{\dot{h}}{V}\right)\left[\frac{1+\tau_1 \rho}{1+\tau_2 \rho}\right]$$

where V is velocity, and τ_1 and τ_2 depend on velocity, altitude and dimensions of the wing section. Lifts and moments thus generated are fed back into the structure simulation.

"We have not yet reached the point where we are ready to try the aerodynamic simulation in conjunction with either one of the structure simulations. At the present time both structure simulations are giving us stability difficulties. However, we hope that the troubles will shortly be cleared away so that flutter investigations can be started."

References

(a) Baird, Pines & Winson, "The Solution of Two Problems of Four Degrees of Freedom Flutter by Electronic Analog Computation," Project Cyclone Report, Reeves Instrument Corp., New York, Feb., 1952.

(b) M. Yanowitch, "Solution of a Flutter Problem," Project Cyclone Report, Reeves Instrument Corp., New York, June 1955.

(c) C. E. Howe and R. M. Howe, "Application of Difference Techniques to the Lateral Vibration of Beams Using the Electronic Differential Analyzer." Engineering Research Institute, Dept. of Aeronautical Engineering, University of Michigan, Ann Arbor, Michigan.

(d) V. L. Larrowe, "Direct Simulation Bypasses Mathematics, Simplifies Analysis." Control Engineering, Nov., 1954.

(e) C. H. White, "Airforces on an Oscillating Airfoil in a Two Dimensional Supersonic Flow—Part II," an unpublished paper of the Analysis Laboratory, California Institute of Technology.

INFORMATION (Without Theory)

After all these years the Simulation Councils are now a legal entity, Simulation Councils Inc., a California corporation with an interim board of directors. Charters will be offered to the six individual Councils and others which may be formed. The very flexible articles of incorporation allow these charters to be modified to allow the separate Councils to operate as they see fit. When the modified charters have been accepted by the interim board of directors, each Council will designate a member of the first regular board of directors, and the interim board will be dissolved.

Attending any Simulation Council meeting and checking a column on the attendance sheet indicating your wish to be considered a member will constitute membership. Resignation will be by letter to the Secretary. No other changes in the operation of the Councils are contemplated, as the planning and conduct of meetings, levying dues if any and such are still strictly local matters.

The only reason for legalizing our operation is to protect individual members from suit for their statements or actions in connection with the Council. Now anyone who doesn't like what we say or do will have to sue Simulation Councils, Inc. and as that corporation is, literally as well as legally, a non-profit organization, such action would be profitless.

* * *

Bendix Computer Division has opened new training facilities in Santa Monica. The complete computer installation will include the DA-1 digital differential accessory which permits direct programming of differential equations.

* * *

We hear that Mid-Century Instrumatic has been suffering from growing pains but is now "refinanced and reorganized" and stronger than ever. Don't know what the reorganization involved, as our friend *Tim Sutton* tells us that key personnel are still with them. Anyway, we wish them luck and hope the pains stop, but not the growing.

Thot - ?

Our recent heat wave—the hottest July 4th in history of San Diego (89°!)*—elicited the following from a colleague. "Wonder if these wiseguys who are so hell-bent on transistorizing everything realize how many customers they will alienate if they ever get computers to run so cool that they don't have to be operated in an air-conditioned room.

*A little cooler on the beach at La Jolla, but still warm enough to make the usually frigid Pacific feel wonderful.

He Went Thataway!

Albert J. (Jack to us) *Mallinckrodt* to Communications Research Laboratories, 13302 Ontario Drive, Garden Grove, Calif. Jack's new company offers "consulting engineering services in advanced communications theory and techniques; propagation and noise analysis; coding and modulation; statistical filter design; applications to radar, navigation and instrumentation."

Computer Events

Fourth Annual Symposium on Computers and Data Processing

Dates: 29-30 August 1957
Place: Denver Research Institute, University of Denver, Denver 10, Colo.
For information write C. A. Hedberg, Head, Electronics Division, University of Denver

Cental Simulation Council

Date: 16 September 1957
Place: Boeing Airplane Company, Wichita, Kansas
Subject: "Hardware Tie-Ins"
For information write Harry Cordes, Boeing

Symposium on Analog and Digital Computation and System Dynamics

Dates: 19-20 November 1957
Place: Wright Air Development Center, Wright-Patterson Air Force Base, Ohio
There will be one combined session on topics of interest to all groups, followed by separate meetings on digital computation, analog computation, and system dynamics. For information write A. C. Robinson, Aeronautical Research Laboratory, WCRRY, Wright Air Development Center.

International Simulation Council

Dates: 9-12 December 1957
Place: Washington, D.C.
This will be held in conjunction with the Eastern Joint Computer Conference. For information write Dr. Harold Skramstad, National Bureau of Standards, Washington 25, D.C.

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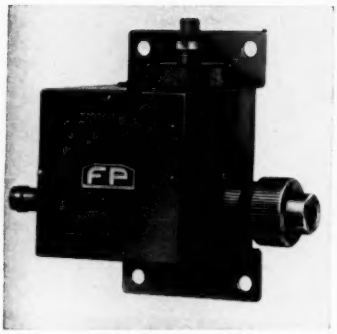
For more information circle **67** on inquiry card.

Preview of the
12th Annual I.S.A. Show

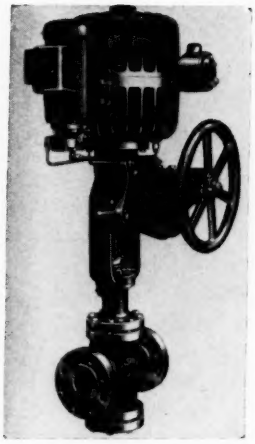
Leeds & Northrup will have a working demonstration of a sulfuric-acid plant with a complete ten-channel digital data-handling system as its main attraction, also a new telemetering recorder hooked-up to the Mid-West power pool lines, plus the latest L&N instruments including a guarded Wheatstone bridge, batch-type Coulometer, a dropping mercury electrode assembly (shown), double-range frequency recorder, and gas chromatography analyzer.

For more information circle **301** on inquiry card.



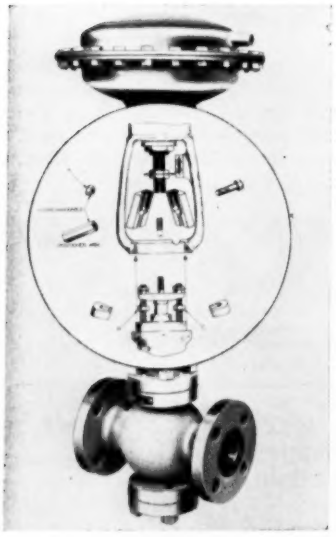
Fischer & Porter Co.'s new O-R-P cell for control of oxidation-reduction processes will be the star in an exhibit of new products, including a pneumatic process simulator, transistorized components of the F&P multiple-pressure readout system, pressure transducer, digi-coder, precision pressure comparator, etc.

For more information circle **303** on inquiry card.



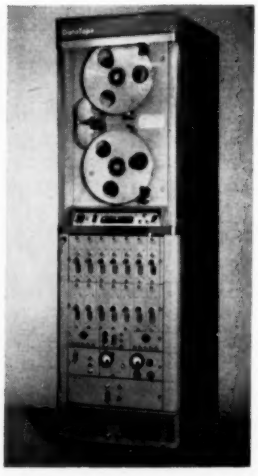
Fisher Governor Co. will display (1) a new line of completely self-contained electrohydraulic valve operators (shown); (2) the new electro-pneumatic valve positioner, and (3) a new series of "Wizard" pressure controllers (Type 4160).

For more information circle **305** on inquiry card.



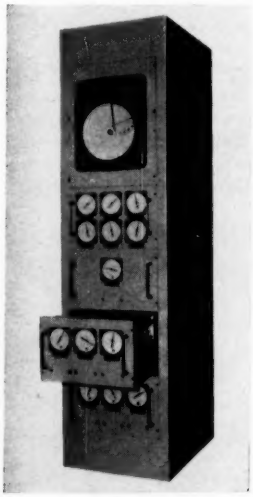
Hammel-Dahl Co. will exhibit newly-modified pneumatic actuators for control valves.

For more information circle **302** on inquiry card.



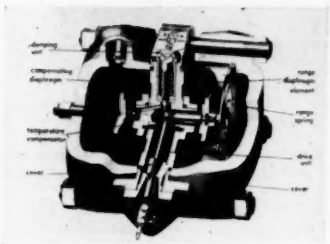
Consolidated Electrodynamics Corp. (CEC) will feature the new modular magnetic tape recorder/reproducer system (Type 5-752) which can handle analog, PDM, and FM signals. Also on display will be the new Type 5-122 recording oscillograph suitable for temperatures from −65°F to +250°F at altitudes up to 120,000 ft.

For more information circle **304** on inquiry card.



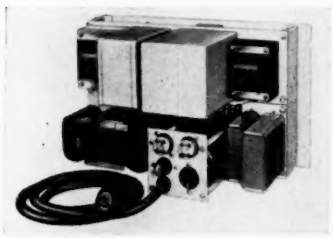
Bailey Meter Co.'s new performance monitor enables operators in power and process plants to see at a glance how efficiently their process is performing. Results are recorded and can be fed into a data logging system for presentation on typed sheets or punched tape.

For more information circle **306** on inquiry card.



Foxboro's new entries into the ISA Show will include the new Type 37 aneroid flowmeter featuring stacked diaphragms (see picture); the new Type 13FA d/p cell transmitter mounting directly on a tank nozzle (shown); the new integral-orifice d/p cell transmitter for small flows; and new panel-type "Consotrol" instruments which have seven new features.

For more information circle **307** on inquiry card.



Newly developed products of **Superior Electric** include high-frequency variable transformers, a new double-wound Powerstat with isolated secondary, and automatic voltage regulators (the 1-KVA tubeless magnetic Type TM 7101 in the latter group is illustrated).

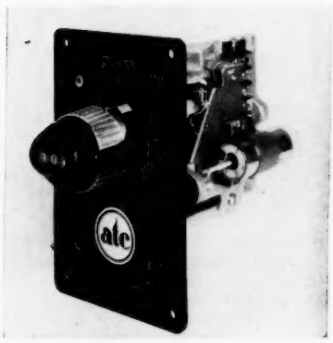
For more information circle **308** on inquiry card.

Industrial Pyometer and Supply Co. will have new products on display which were recently included in its line of thermocouples, lead wires, aircraft temperature wires and cables, etc.

For more information circle **309** on inquiry card.

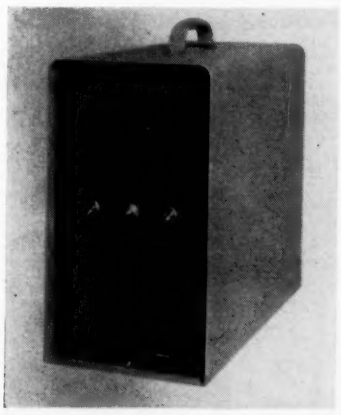
In **The Bristol Company's** thirteen booths there will be about ten new developments on display, including a new electronic transmission system with 3" strip chart recorder; a digital computer for computing compensated flow values from telemetered measurements; a 2-pen pneumatic recording receiver with one-pen cascade control; a low-noise chopper with frequency range of 0 to 1800cps in dry circuits; etc.

For more information circle **310** on inquiry card.



Automatic Temperature Control Co. (soon changing its name to Automatic Timing and Controls, Inc.) will have on display new printed-circuit electronic timers; hermetically sealed timers for airborne or ground control equipment; and new micrometer positioners used as zero adjusters, range suppressors or calibrated micrometer positioners (shown).

For more information circle **311** on inquiry card.

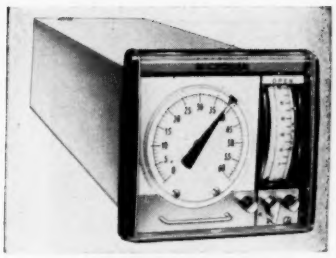


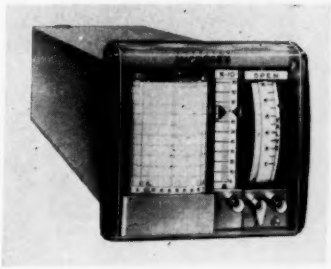
Gilmore Industries will exhibit the illustrated portable force calibrator, besides a direct-reading digital servo indicator, and the new Model 114 Autographic Plotter.

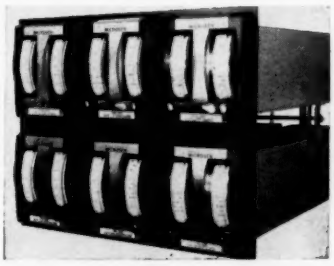
For more information circle **312** on inquiry card.

W. & L. E. Gurley's line of anemometer and wind direction transmitters and indicators, current meters, tripods, reticles, etc. will include their latest developments.

For more information circle **313** on inquiry card.

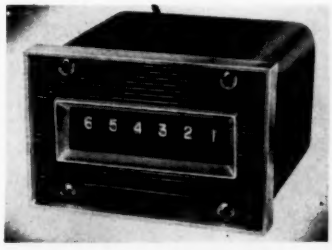






Manning, Maxwell & Moore's Industrial Products Div. will display its new Microsen miniature indicators, recorders, and controllers, among them (1) a multi-unit controller-recorder, (2) a transistorized recorder-controller, and (3) an indicating controller (all shown). Other new developments in the line are indicating controllers with vertical scale, manual-automatic stations, and millivoltmeter-recorders.

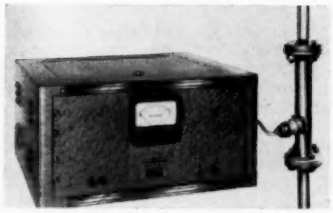
For more information circle **314** on inquiry card.



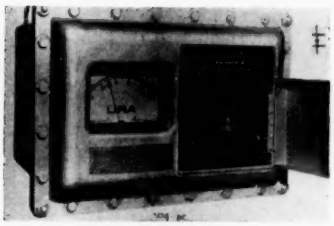
The exhibit of **Autron Engineering Inc.** features a new photoelectric detector and a companion light beam projector, both of sub-miniature size; "Neuron" electromechanical counter-totalizers (illustrated) and the new Autron Model 6365 temperature controller.

For more information circle **315** on inquiry card.

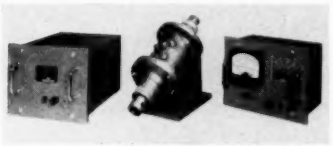
Technical Products Co. will show its new TP-625 frequency analyzer.
For more information circle **316** on inquiry card.



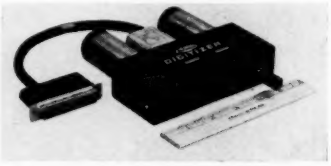
Industrial Development Labs will display the Laub electrocaloric flowmeter (shown); also a new temperature transducer.
For more information circle **319** on inquiry card.



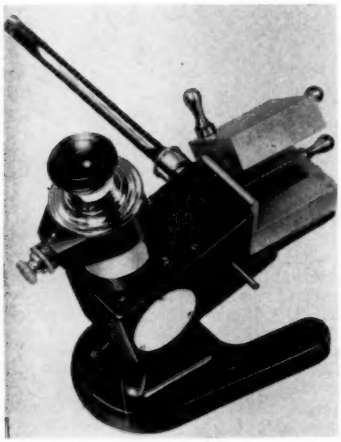
Mine Safety Appliances Co. will feature the Model 200 Lira, a new infrared analyzer.
For more information circle **323** on inquiry card.



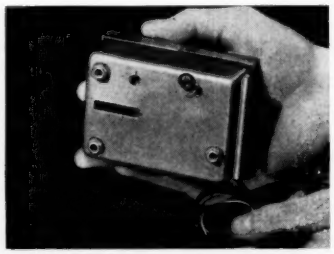
Electrodeless electrolytic conductivity equipment will be shown by **Industrial Instruments, Inc.**; also a battery-operated recorder.
For more information circle **320** on inquiry card.

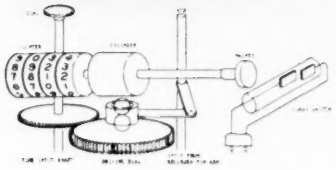


Coleman Engineering Co. will exhibit its new Digitizer which converts analog data to digits by means of shaft rotation.
For more information circle **324** on inquiry card.

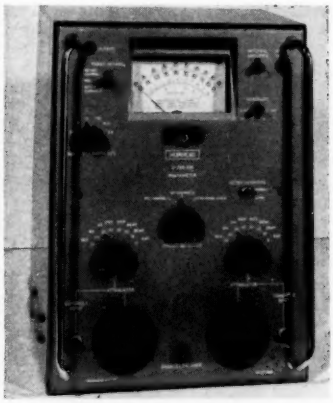


Epic, Inc. will exhibit foreign-made sugar and oil refractometers (shown), pipeline refractometers, and polarimeters for the first time.
For more information circle **317** on inquiry card.

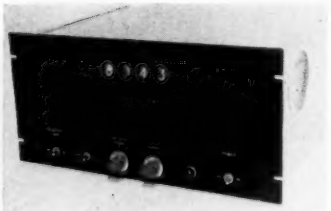




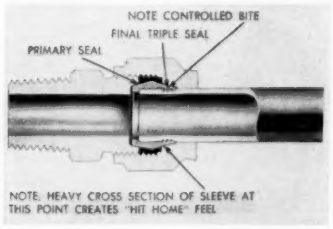
Librascope, Inc. will feature its linear integrator Model 25 with its unique ball-and-disc integrating mechanism.
For more information circle **321** on inquiry card.



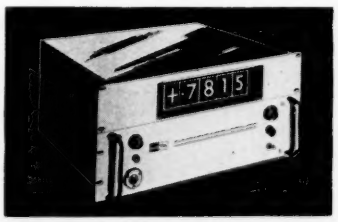
Muirhead Instruments will exhibit its new D-729-B low-frequency phase meter.
For more information circle **325** on inquiry card.



I-L-S Instrument Corp. will have the first showing of its Model 1290 electronic tachometer using "Nixie" numerical indicators.
For more information circle **318** on inquiry card.


NOTE CONTROLLED BITE
FINAL TRIPLE SEAL
PRIMARY SEAL
NOTE: HEAVY CROSS SECTION OF SLEEVE AT THIS POINT CREATES "HIT HOME" FEEL

Imperial Brass will have a new type of flareless fitting ("High-Seal") as a "first" at the show.
For more information circle **322** on inquiry card.



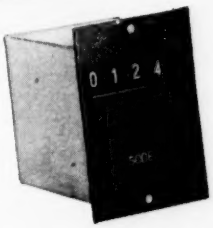
The KIN TEL new digital voltmeter capable of directly driving printout units will be the main new product of Cohu Electronics, Inc. on display; also new wide-band d-c amplifiers, micro-voltmeters, ITV monitors, etc.
For more information circle **326** on inquiry card.

SHORT

in size . . .

LONG

in performance



NEW SODECO

Type TCeBZ Electric Impulse Counters

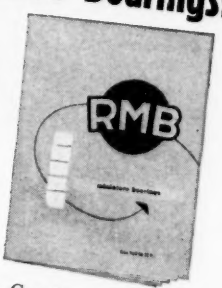
The latest in the SODECO line, these new electric impulse counters offer designers a wonderful opportunity to squeeze a high-performance impulse counter into a very limited space.

ALSO ON DISPLAY:—

- SODECO electrical impulse and preselection counters with manual or electrical reset.
- SODECO high-speed impulse counter and impulse transmitter
- SODECO adding and subtracting counter
- SODECO pulse-operated decades

Work with Miniature Bearings!

You'll want the NEW RMB Catalog!



The new RMB Miniature Bearing Catalog is now available. And what a compendium of useful information it is! Just off the press, it contains a listing of and all vital information pertaining to the function and use of the famous RMB line of miniature bearings.

Included in the RMB Miniature line are:

1) Miniature Radial Filmoseal® Sealed Bearings*
2) Miniature Radial Bearings*
3) Miniature Radial Ultra-Light Bearings*
4) Miniature Roller Bearings
5) Miniature Pivot Bearings (with or without inner race)
6) Miniature Radial Bearings Without Inner Race
7) Miniature Special Bearings*

*available in several inch sizes, and in ABEC Class 1 tolerance as well as ABEC Class 5.

See them all at the Instrument Show

Booth 115

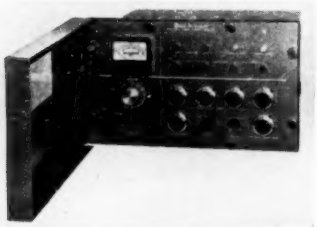
Get all the latest data on RMB Miniature Ball Bearings and Sodeco Electric Impulse Counters

You'll be more than welcome

LANDIS & GYR, INC.

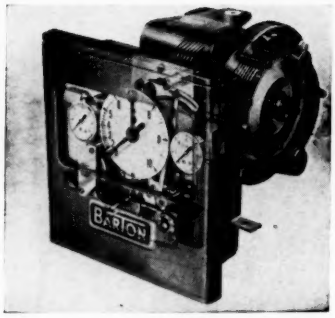
45 West 45th St., New York 36, N. Y.

For more information circle **68** on inquiry card.



Beckman Instruments, Inc. will enter the show with its new, low-cost gas chromatograph control unit and analyzer, base priced at less than $5000.

For more information circle **327** on inquiry card.

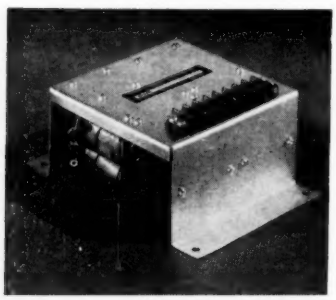


Barton Instrument Corp.'s "firsts" are its differential pressure controller (Model 237) and an indicating flow switch (Model 234).

For more information circle **331** on inquiry card.

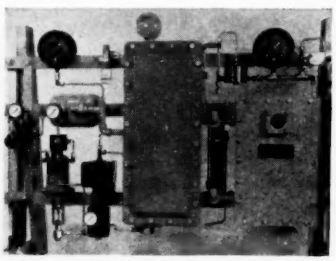
Epsco Incorporated will exhibit its new Model DA-101 wide-band true-differential amplifier which amplifies low-level differential signals and rejects common-made noise and hum pickup.

For more information circle **335** on inquiry card.



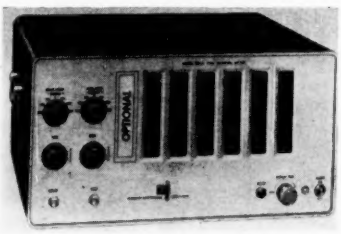
Electro Products Labs will have three new products to show for the first time: the Model 3440 over/under speed control utilizing a magnetic amplifier (illustrated); an over/under speed control relay; and a new miniature magnetic pickup.

For more information circle **328** on inquiry card.



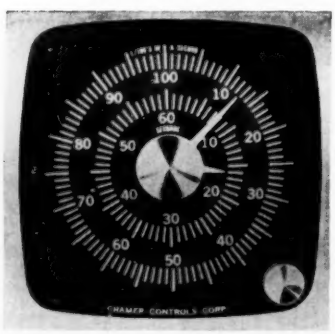
Hallikainen Instruments will introduce the Hallikainen-Shell vapor pressure recorder (illustrated is the Model 1157 for gasolines and other low-pressure hydrocarbons).

For more information circle **332** on inquiry card.



Computer-Measurements Corp. will unveil its new time-interval meter Model 251-A for precise measurement of elapsed time in the range of 3 microseconds to one second (illustrated). Shown also will be the new frequency-period counter, Model 203-A.

For more information circle **336** on inquiry card.

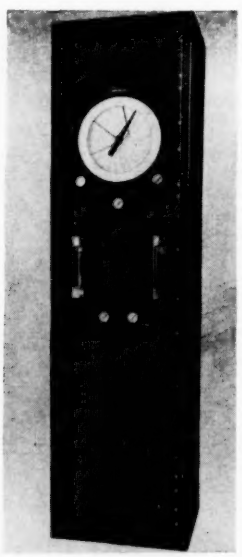


New products at **Cramer Controls'** exhibit will be the Type 117 permanent-magnet synchronous motor, and a new electric stop clock with instantaneous electrical reset (picture).

For more information circle **329** on inquiry card.

Conoflow Corp. will have an operating exhibit of its new Model "P" pressure transmitter, especially suitable for viscous materials and liquids with solids in suspension.

For more information circle **333** on inquiry card.



Gow-Mac Instrument Co. will exhibit new anemometer cell Model 9580 for very low gas flow rates; also a new gas blender for thermal-conductivity gas analysis.

For more information circle **337** on inquiry card.

Friden Calculating Machine Co. will have two new developments at its exhibit: (1) the Teledata tape transmitter-receiver, and (2) a punched-tape regeneration unit.

For more information circle **330** on inquiry card.

Systron Corp. will have its new industrial counter-controller Model 1040 on display with a time base continuously selectable from 0.001 to 100 seconds in increments of 1 millisecond.

For more information circle **334** on inquiry card.

How to take an entire laboratory for a ride

Get complete mobile data despite shock and limits of space

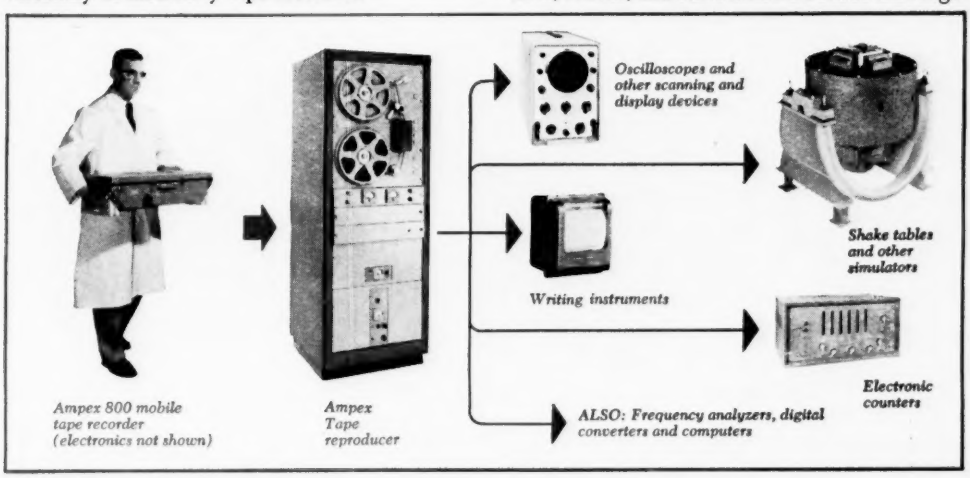
This is the easy way – no such blue-sky dream as a shock-mounted, air-conditioned brick building on wings or wheels. The earthbound laboratory has a "double" that rides on airplanes, vehicles or ships or goes to location by manpower, muleback or dolly. The secret . . . an Ampex 800 mobile tape recorder which simultaneously gathers data for the laboratory's writing, viewing, simulating and computing instruments. Despite adverse environment, Ampex 800s closely match precision and versatility of laboratory tape recorders.

AIRBORNE APPLICATIONS

Ampex 800s are widely used for environmental data, radio signals, radiation information, weapon countermeasures, flight parameters, etc.

At one airforce facility, the Ampex 800 rides in one aircraft to record telemetered signals from another (unmanned). Altitude greatly extends the horizon and tracking distance over which line-of-sight telemetered signals can be received.

Aircraft companies are tape recording vibrations, sounds, and other data far outside the range of other recording techniques. And in one major company's flight-test program, 420 channels of data are multiplexed onto a one-inch tape.


Oscilloscopes and other scanning and display devices
Shake tables and other simulators
Writing instruments
Electronic counters
Ampex 800 mobile tape recorder (electronics not shown)
Ampex Tape reproducer
ALSO: Frequency analyzers, digital converters and computers

Only this mobile tape recorder and its associated equipment undergo the hazards and space limitations of the mobile test situation.

Reproduction of the tape recreates the original transducer voltage patterns, providing every other laboratory instrument with the same input it would have received if it too had been carried on the test. Data slowdown, speed-up, filtering, etc. can be used.

Ampex 800 tape transport, showing small size and ease of handling. This is the largest of the recorder components.

GROUND, SHIPBOARD AND VEHICLE USE

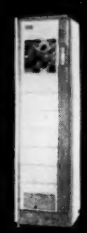
The Ampex 800 is light and rugged, withstands handling and sets up quickly and easily. A research group studying earth-transmitted shock waves carries the Ampex 800 right to locations next to railroad tracks, airfields, highways and other areas of interest. An oil company uses a truck-mounted 800 to log oilwells in the fields.

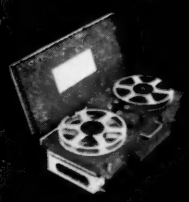
The equipment stands shock, vibration and noise. In a shipboard installation, the Ampex 800 gathers data on closeby underwater explosions, enduring shocks transmitted through the ship. At an eastern jet-engine test facility, dolly-mounted Ampex 800s are wheeled out to the cells and get accurate data in an area of intense noise.

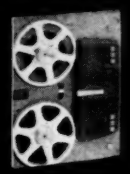
Do you have a mobile data acquisition problem on which we can help? Or would you like this tape-recording series mailed to you direct? For either request, write Dept. BB-8.

MAGNETIC TAPE APPLICATIONS BY AMPEX

6







AMPEX CORPORATION

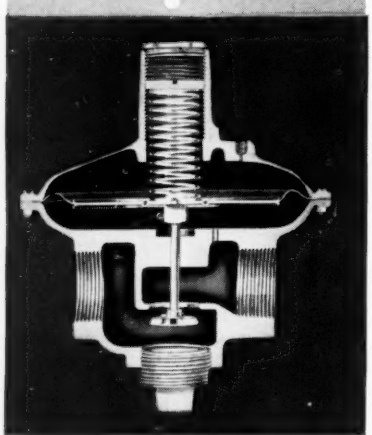
FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 CHARTER STREET · REDWOOD CITY, CALIFORNIA

District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.

For more information circle **69** on inquiry card.

WHAT'S INSIDE MAKES A BIG DIFFERENCE



Regulators and Controls are as good as the diaphragms actuating them.

Vulcan diaphragms have been accepted and depended on for almost 25 years.

Low gauges are available with excellent flexibility for delicate applications. Heavy gauges with high strength for rugged service are available in many coating compound types.

Vulcan provides integrated research, development and manufacturing facilities. This means complete quality control from raw material to finished product; assuring you that every diaphragm is made to strict specifications.

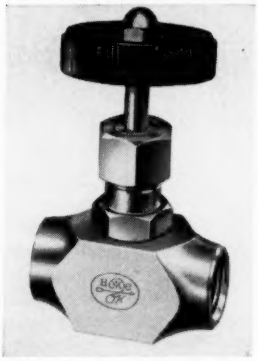
A vital part of this Vulcan integration is our research and development laboratory. If you have a diaphragm problem, we shall be happy to consult with you.

Another REEVES VULCAN RUBBER PRODUCT

Write to: Dept. I-7
REEVES BROTHERS INC.
Vulcan Rubber Products Division
54 Worth Street • New York 13, N.Y.

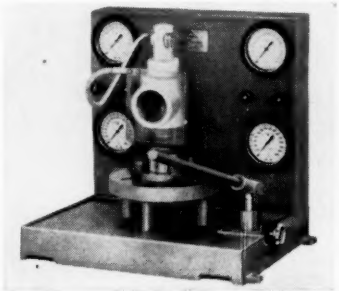
For more information circle **70** on inquiry card.

SHOW PRODUCTS—Cont.



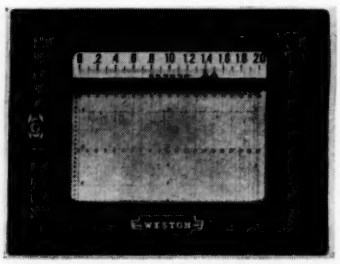
Hoke Incorporated will display the new stainless steel metering valves series PY270.

For more information circle **338** on inquiry card.



Farris Engineering Corp. will exhibit the new "Porta-Tester" (shown), and a series of "super-capacity" pop safety valves.

For more information circle **339** on inquiry card.

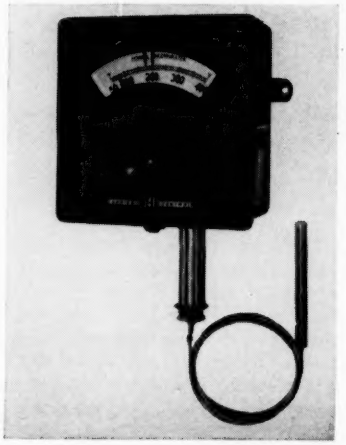


Weston Instruments Corp. will show three new models in the 6700 series of strip chart recorders and controllers (controller shown); new induction modulators, a new-principle d-c to a-c transducer; higher rated "Vamistors"; and a new sensitive miniature hermetically-sealed relay.

For more information circle **340** on inquiry card.

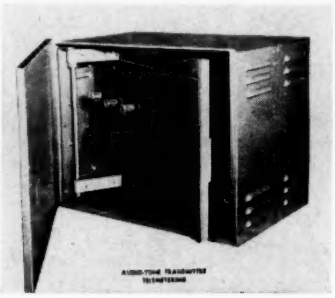
Tenney Engineering will have on display (1) the TH humidity chamber, (2) a refrigerated test chamber the 'Tenney-Mite" bath.

For more information circle **341** on inquiry card.



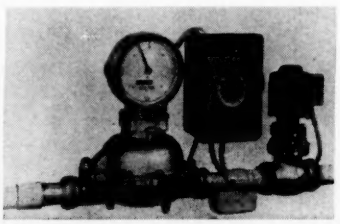
Fenwal Incorporated will have its new Series 541 temperature indicating controller on display (picture) and will demonstrate its new temperature control and indicating console system.

For more information circle **342** on inquiry card.



Femco, Inc.'s new products on display include audio tone panels (telemetering transmitter shown); carrier shift transmitters and receivers; phase switchers; and circuit scanners.

For more information circle **343** on inquiry card.



Buffalo Meter Co. will exhibit its new "Electrivolume" control system for automatic batching, utilizing an impulse counter. Also a "first" will be a Niagara chemical meter of type 316 SS construction.

For more information circle **344** on inquiry card.

Burroughs Corp., Electronic Tube Div., will show the in-line read-out "Nixie", along with a decade counter, and a transfer storage counter.

For more information circle **345** on inquiry card.

Counter and Control Corp. will exhibit its new adjustable program timer.

For more information circle **346** on inquiry card.

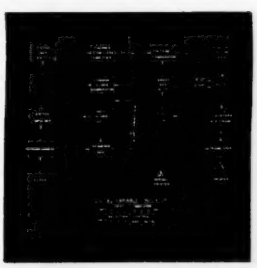
KYBERNETES®

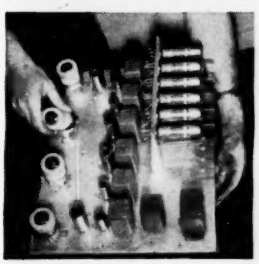
THE KYBERNETES CORPORATION

Division of Self Winding Clock Company, Inc.
for 70 years leader in time standards
and precision engineering

ALL ELECTRONIC LINE OF AUTOMATIC DATA PROCESS LOGGERS

A revolutionary engineering concept, the
Kybernetes Electronic Data Logger
puts to use designs largely predicated
upon advanced techniques
developed by the computer industries,
featuring reliability and accuracy.





Write for Bulletin '108'

THE KYBERNETES CORPORATION

Executive Offices:
9 East 40th Street
New York 16, N. Y.
MUrray Hill 3-6030

KYBERNETES®

For more information circle **71** on inquiry card.

Waugh

See our Complete Display BOOTH 409 I.S.A. Show

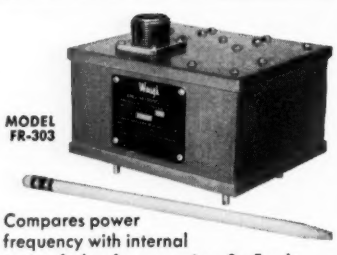
TRANSISTORIZED FREQUENCY-to-VOLTAGE CONVERTERS

MEASURE AND CONTROL:

- **Flow Rate**
- **R.P.M.**
- **Power Frequency**
- **Linear Speed**

MODEL FR-302 SUBMINIATURE CONVERTER

Detects AC signals down to low amplitude levels, converts to 0—5 volt DC signal proportional to frequency within .2%, gives .25% long term stability with less than .002% per degree temperature coefficient.



MODEL FR-303

Compares power frequency with internal tuning fork reference, gives 0—5 volts DC between 370 and 430 cps, with .05% overall accuracy under severe vibration and temperature conditions.

20 standard modifications of the FR-300 series converters are available to suit every airborne and ground requirement.

TURBINE FLOWMETERS

...covering flow rates from .065 to 6000 GPM... are standard testing equipment in the newest missiles and aircraft, where the ultimate in reliability and accuracy are required.

Write for Complete Data

STanley 3-1055

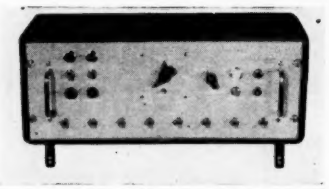
Waugh ENGINEERING COMPANY

FLOW MEASUREMENT AND CONTROL

7842 BURNET AVENUE, VAN NUYS, CALIFORNIA

For more information circle **72** on inquiry card.

SHOW PRODUCTS—Cont.

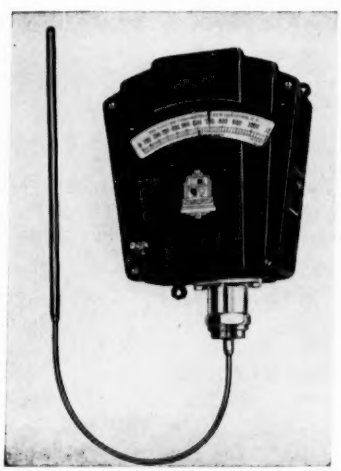


Sanborn Co.'s new Model 158-5490 eight-channel recording system with new Model 183 programmer will have its premiere.

For more information circle **347** on inquiry card.

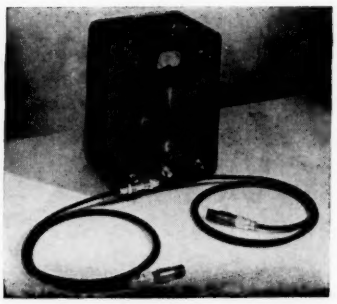
Brooks Rotameter Co. will show its new TransiTwins flow transmitters which are interchangeable; the transmitter which employs direct-force balance, and the electric transmitter which utilizes a strain gage element.

For more information circle **348** on inquiry card.



Partlow Corp. will feature the new Model HL15-10 indicating high temperature limit controller.

For more information circle **349** on inquiry card.

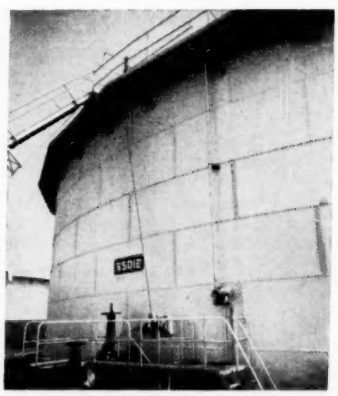


Kistler Instrument Corp. will introduce its new SLM DPI-114 differential-pressure indicator with crystal-type transducers.

For more information circle **350** on inquiry card.

Palmer Thermometers will have its new 3½" bi-metal thermometer Model 1035 on display.

For more information circle **351** on inquiry card.



Vapor Recovery Systems Co. (VAREC) will exhibit its pulse code telemetering system for tank gaging.

For more information circle **352** on inquiry card.

Aero Service Corp. will exhibit the new Model E Haag-Streit coordinatograph for plotting over a 60" x 120" working area.

For more information circle **353** on inquiry card.

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 5

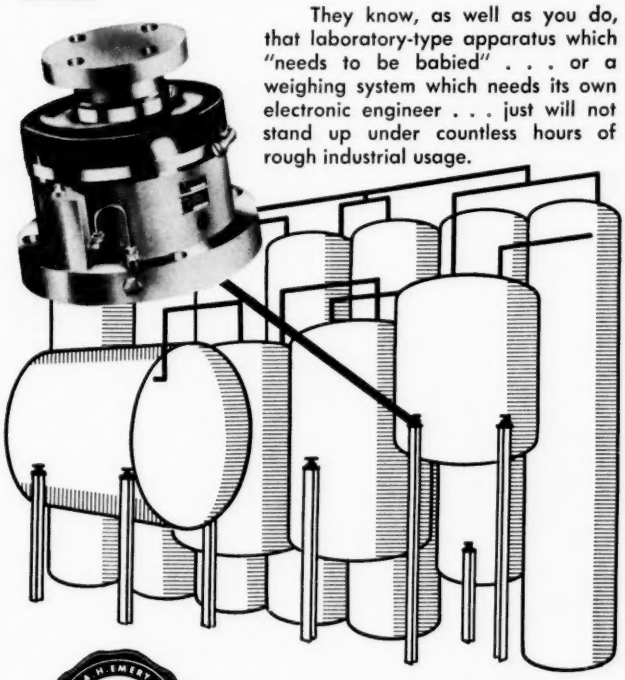
Covering design, development and application data on Emery Weighing Systems for industrial applications

TOP EXECUTIVES FIND EMERY WEIGHING SYSTEMS SUITABLE FOR TOUGHEST WEIGHING APPLICATIONS IN PROCESSING FIELD

Vision And Experience Team Up To Decide On Maintenance-Free Hydraulic Equipment

Men with progressive vision and broad experience in the processing industries are becoming increasingly aware of the need for positive action, extreme accuracy and maintenance-free long service life in the control equipment they buy for their plants. Why? Because in these days of tough "break-even" points and narrow profit margins, they can't afford to take chances.

They know, as well as you do, that laboratory-type apparatus which "needs to be babied" . . . or a weighing system which needs its own electronic engineer . . . just will not stand up under countless hours of rough industrial usage.



The Emery Load Cell is a "husky" piece of industrial equipment which combines years of satisfactory performance with amazing accuracy. A unique design called the "rolling ball" head accommodates reasonable off-center and cross loads. Even though Emery Load Cells utilize hydraulic pressure as a sensitive medium to measure loading they can be teamed with practically any brand or type of instrumentation manufactured today.

There are many good reasons why top executives are specifying Emery Load Cells for their bin, tank and hopper weighing applications. Our new Bulletin 561 describes them in detail. Send for this literature today.

A practical handbook on bin, tank and hopper weighing and the instrumentation involved. Write for it now!

THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.

For more information circle **73** on inquiry card.

PRECISION

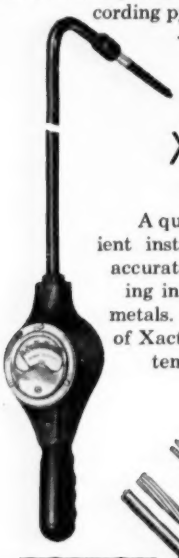
TEMPERATURE

measurement and control

GORDON

XACTLINE

Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.



GORDON

XACTEMP

Hand Pyrometer

A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

GORDON

SERV-RITE

Thermocouple Wire

Thermocouple Extension Wire

Insulated in Gordon's own plant to assure consistent quality.
All standard wire and insulations carried in stock for quick delivery. Other wires, in long or short runs, manufactured to specifications.

Full Particulars on Request

GORDON SERVICE 5607

CLAUD S. GORDON CO.

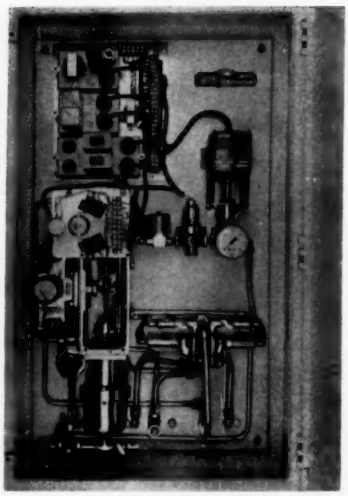
Manufacturers • Engineers • Distributors

Temperature Control Instruments • Thermocouples & Accessories • Industrial Furnaces & Ovens • Metallurgical Testing Machines

609 West 30th Street, Chicago 16, Illinois

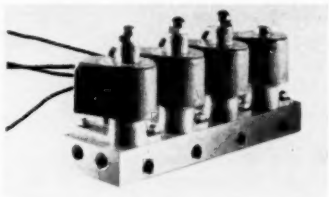
2025 Hamilton Avenue, Cleveland 14, Ohio

For more information circle **74** on inquiry card.



A. W. Cash Co. will display the Sparton-Cash Standard Series 300 packaged control system for remote positioning of butterfly, plug, and other valves by electrohydraulic or electropneumatic means. New diaphragm control valves will be shown also.

For more information circle **354** on inquiry card.



Automatic Switch Co.'s line of solenoid valves and electromagnetic controls will be enlarged by the first showing of a sanitary pilot-controlled solenoid valve two- and three-way valves with nylon bodies, high-pressure (1500 psi) valves, midget three-way valves, and manifold two- and three-way valves (illustrated).

For more information circle **355** on inquiry card.

Eder Instrument Co. will show a new blind-hole inspection telescope with sidewall viewing adapter.

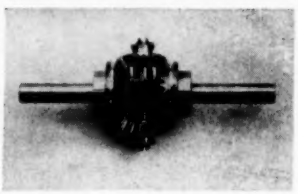
For more information circle **356** on inquiry card.

Curtiss-Wright Corp., Research Div. will demonstrate "Thermocolor" and "Thermochrom" temperature indicating pigments and sticks, respectively, which were developed in Germany.

For more information circle **357** on inquiry card.

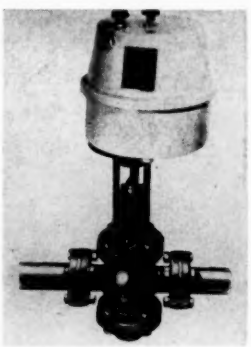
Jerguson Gage and Valve Co. will show its new No. 23 drain or sampling valve.

For more information circle **358** on inquiry card.



Dynamic Gear Corp. will show its new bearingless differential.

For more information circle **359** on inquiry card.



Askania Regulator Co.'s entry in the new product array at the show will be its new electrohydraulic valve actuator for use with low-level a-c or d-c signals.

For more information circle **360** on inquiry card.

Gulton Industries will show the multiuse application of components and instruments recently developed by its various divisions and subsidiaries.

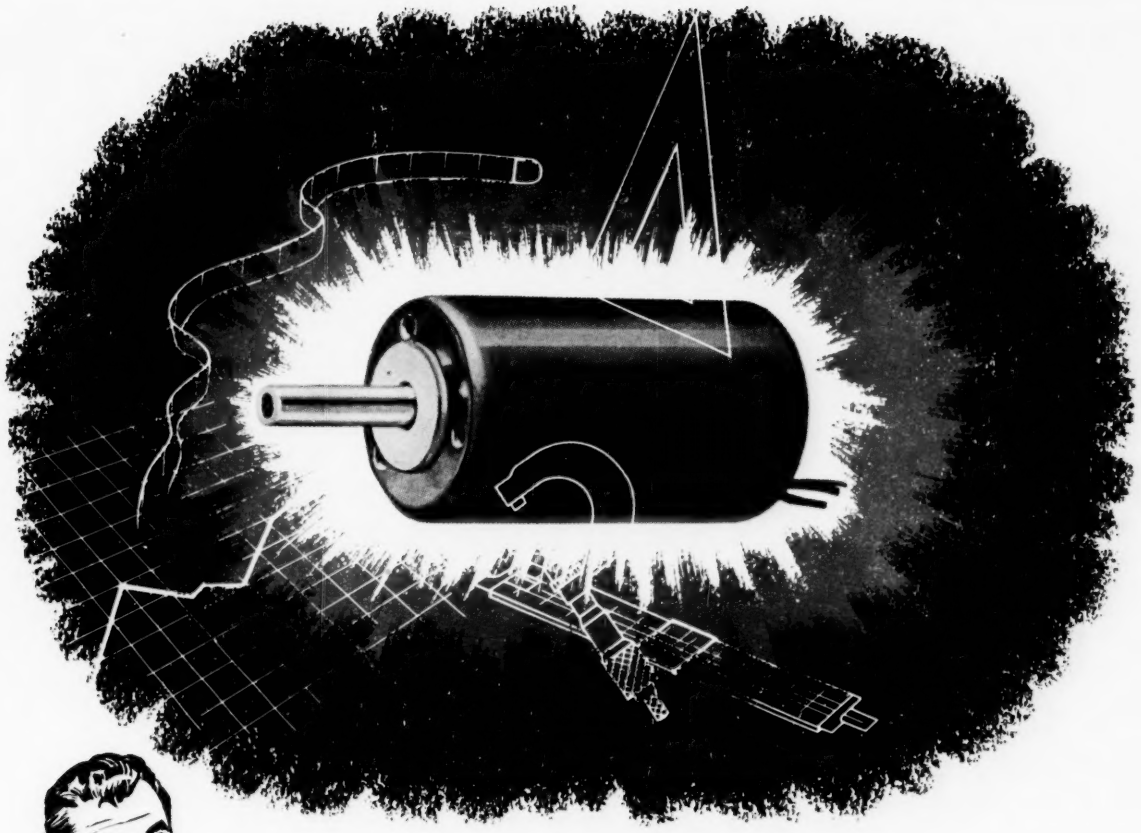
For more information circle **361** on inquiry card.

Tempil Corp. will show latest developments of its temperature-indicating materials.

For more information circle **362** on inquiry card.

Minneapolis-Honeywell, Industrial Div., will exhibit a digital potentiometer with four-figure digital readout and pinboard programming. Also to be disclosed will be a 2-pen Tel-O-Set recorder with control on one pen.

For more information circle **427** on inquiry card.



HOW DO YOU MEASURE A MOTOR?

EAD'S 1" Diameter Motor Exceeds 3500 Hours at 20,000 RPM

An EAD customer required a small, 1" diameter motor with a minimum life of 1000 hours, running at 20,000 rpm at a temperature of 85° C. The result was peak performance at specified temperature and speed for more than 3500 hours operation with no signs of deterioration!

This is a typical example of EAD's high-output, long-life, power-packed miniature components doing a big job!

by PRECISION

Consider first the excellence of the electro-mechanical design and the "built-in" precision. What quality are the bearings and lubrication? Can you hold air gap clearances of less than .002" required for high efficiency? How does the motor measure up under extreme environmental conditions?

EAD pioneered precision in small motors . . . specialized in small precision motors for more than 15 years!

by PERFORMANCE

Can you obtain a 1-inch diameter motor with high-power output and efficiencies exceeding 60%? Is it capable of extremely high speeds for fan or blower applications requiring maximum air deliveries? How does it measure up in reliability, long life in control equipment, actuators, pumps, generator drives, gear motors, antenna drives, or automatic devices.

EAD motors are performance-proven for more than 15 years in vital, stringent military and industrial uses!

by PRICE

Can you get premium performance, high-accuracy, specialized design at production prices not much greater than you now pay for standard motors?

EAD has the years of experience to convert complex engineering designs into mass-producible items. You get highly specialized units at standard motor prices!

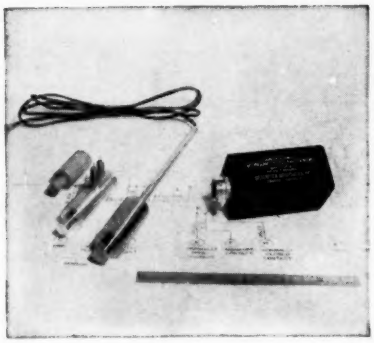
Get all 3 at EAD

EAD Eastern Air Devices, inc.

347 CENTRAL AVENUE, DOVER, NEW HAMPSHIRE

For more information circle **75** on inquiry card.

Airborne Ultrasonic Liquid Level Sensor



Here is a new light weight, highly accurate liquid level point sensor for aircraft, missile fuel and oxidizer systems, and propellant control. Designated Model RC-1A, it operates on ultrasonic principles to detect the presence or absence of liquid at a predetermined level. The basic sensor consists of a miniaturized hermetically sealed ultrasonic probe, measuring approximately 2" in length and 11/16" outside diameter. The probe weighs only one ounce and is always at the ambient temperature of the liquid being gaged.

FEATURES

- **A response time of less than 10 milliseconds**
- **Negligible power drain**
- **Accuracy better than 1/64"**
- **Sub-miniaturized**
- **Light weight**
- **Absolutely no spark or radiation hazard**

An associated plug-in hermetically sealed control unit contains a sensitive relay capable of performing a control or indication function. Weight of this unit is only six ounces.

Various modifications are available to meet your particular needs. Probes capable of sensing cryogenic, highly corrosive, or radioactive liquids are available. Let us know your specifications. There's an Acoustica representative to help you anywhere in the U. S. and abroad. Mail your request for information with your Name, Position, Company, and address to:

DEPT. IA.

ACOUSTICA ASSOCIATES, INC.

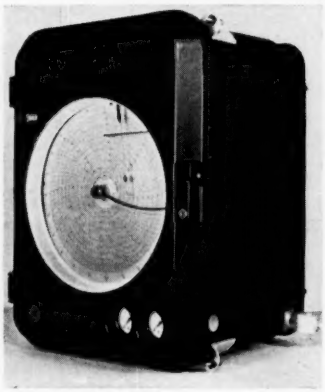
ACOUSTICA ASSOCIATES

Glenwood Landing, Long Island, N. Y.

Phone—Oriole 6-0370-1-2-3

For more information circle **76** on inquiry card.

SHOW PRODUCTS—Cont.

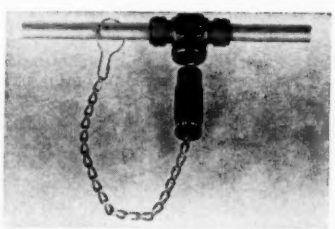


Hagan Chemicals & Controls, Inc. will feature its newly redesigned Ring Balance flowmeter Model 3000 (shown) and the new remote-mounted positioner for manipulating large mechanical equipment.

For more information circle **363** on inquiry card.

Hoke Manostat Corp. will show for the first time its industrial manostat (picture), and a new electronic resistance thermometer with digital readings.

For more information circle **364** on inquiry card.

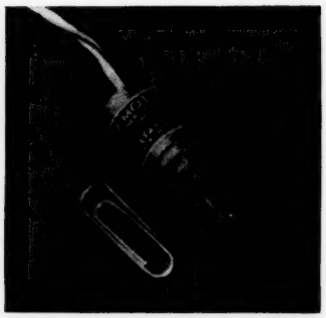


Crawford Fittings Co. will show a new Swagelok Danger Signal Bull Plug which gives immediate warning that unsafe conditions or fire hazards exist.

For more information circle **365** on inquiry card.

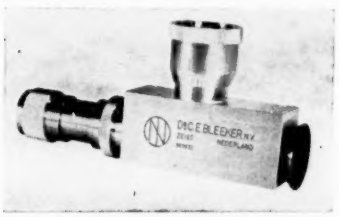
Blonder-Tongue Labs will show the new "Observer" ITV camera and the new Model DVM-17 vidoe monitor.

For more information circle **366** on inquiry card.



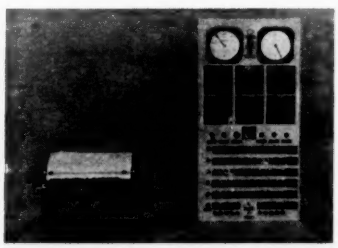
The size of **Norden-Ketay's** new low-inertia miniature servo motor is apparent from picture. Other new miniature components shown for the first time will be the Model 55,000 floated rate gyro, and motor tachometers and tachometer generators. Another "first" at the show will be the transistor analyzer, illustrated here.

For more information circle **367** on inquiry card.



Karl Heitz, Inc. will show the Omag pocket microscope, and the Bleeker pocket spectroscope among a dozen other new imports.

For more information circle **368** on inquiry card.



Shand and Jurs will display the "Datalogger," latest addition to "Telepulse" equipment, which can automatically log liquid levels of 72 large storage tanks every half hour with ⅛-inch accuracy, and print dangerously high or low levels in red.

For more information circle **369** on inquiry card.

The **Okonite Co.** will exhibit new "Armoflex" control tubing and cabled tubes for pneumatic or hydraulic control circuits.

For more information circle **370** on inquiry card.

NEW SERVO-RATIO MULTIMETER

Combines all the functions of an AC-DC voltmeter, ohmmeter and AC-DC ratiometer in one compact portable unit

Here is a new, highly accurate test instrument designed to make life easier for those who work with computers and other electronic and electrical devices. It measures AC-DC ratios, absolute AC-DC voltages and resistance. You can also measure the gain of operational amplifiers using the 0° phase output provided.

The Servo-Ratio Multimeter computes voltage ratios by dividing the voltage to be measured by the reference voltage obtained from the computer. It is a high-impedance instrument and utilizes a motor-driven, position-type servo mechanism. Average time to obtain a reading is three seconds. Simplification and reliability are obtained through the use of printed circuits.

The front panel contains a four-digit illuminated drum counter for readout, phase or polarity indicating lights, function switch, ON-OFF switch, range switch, 0° phase ratio selector, input terminals and 0° phase output terminals.

The Servo-Ratio Multimeter is compact and easy to handle. It has an aluminum case and weighs only 10 pounds. The instrument can be operated in a horizontal or vertical position and has a unique carrying handle that serves as a tilt-stand when the unit is used horizontally. Write for Product Description 2005.

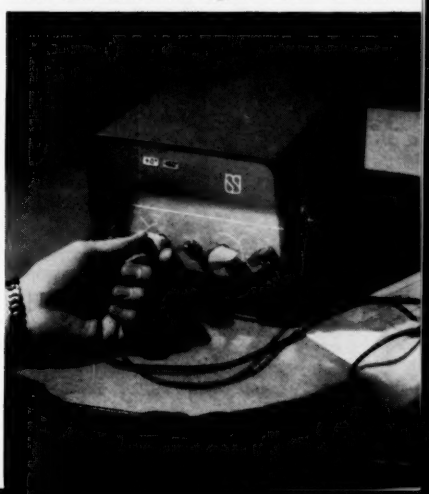
SPECIFICATIONS

Power Consumption: 50 Watts, 110 Volts, 60 cps. Reference Voltage: DC or 60 cps AC; ± 10 Volts to ± 100 Volts across 8.7K Ohms Load.

Functions	Range
Ratio, AC	0.001 to 1.000 ± 0.1% in 1 range
Ratio, DC	0.001 to 1.000 ± 0.1% in 1 range
60 cps AC Voltage	1 Volt to 1000 Volts full scale ± 1.0% in 4 ranges
DC Voltage	1 Volt to 1000 Volts full scale ± 1.0% in 4 ranges
Ohms	10K Ohms to 10 Megohms full scale ± 1.0% in 4 ranges
Gain	0.01 to 1000 in 4 ranges

PORTABLE AND COMPACT—Weighs only 10 pounds. Size: 7⅞" x 5½" x 11-13/16".

SIMPLIFIES TESTING—Eliminates need for many other instruments. Has digital readout counter.

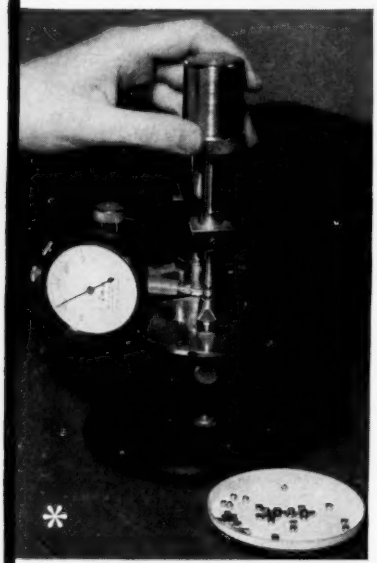


See our exhibit at the ISA Show, Booths 810-811 Cleveland, Ohio, September 9-13.

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

For more information circle **77** on inquiry card.

There's a *Bird*
JEWEL BEARING
to fit Your Need!



Bird can supply you with sapphire and borrosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:

Aircraft Instruments
Weather Recorders
Ammeters
Voltmeters
Wattmeters
Compasses
Dial Gages
Timers
Test & Recording Instruments
Marine Instruments

**Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.*

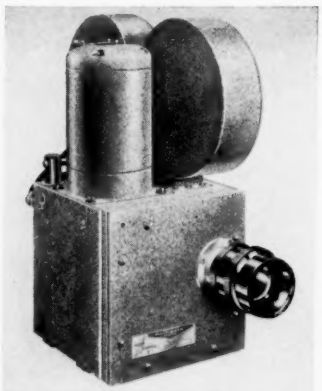
Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

Richard H. Bird & CO., INC.
1 SPRUCE ST., WALTHAM 54, MASS.

SAPPHIRE & GLASS JEWELS
PRECISION GLASS GRINDING
JEWEL MOUNTING & ASSEMBLY

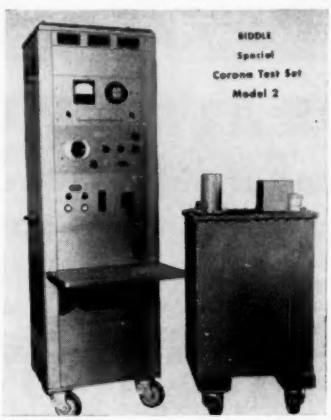
For more information circle **78** on inquiry card.

SHOW PRODUCTS—Cont.



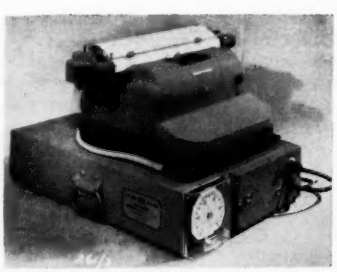
Flight Research Inc. will display its new 70-mm data-recording camera "Multidata", Model V, specifically designed for missile tracking.

For more information circle **371** on inquiry card.



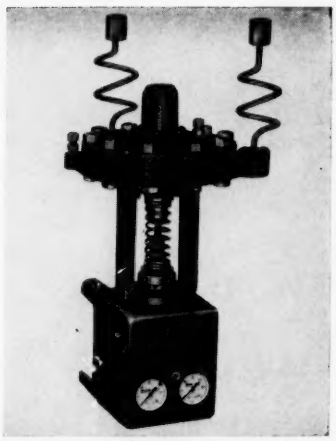
James G. Biddle Co. will have its new Corona test set Model 2 on display for non-destructive evaluation of electrical insulation (shown), also Frahm oscillator controls, Types ROC4 and ROC2 for maintaining oscillator output within close limits.

For more information circle **372** on inquiry card.



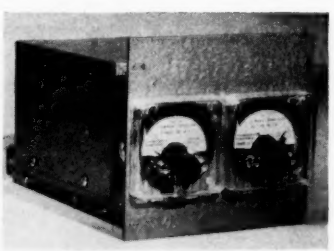
Hanson-Gorrill-Brian's newly developed portable automatic data logger the "Data-Master" Model 4 will be unveiled at the show.

For more information circle **373** on inquiry card.



Leslie Co.'s new products with "firsts" at the show include a floatless, differential-pressure-type liquid level control pilot, and springless diaphragm actuated pressure reducing valve (both illustrated), as well as a new water reducing valve.

For more information circle **374** on inquiry card.



Assembly Products will show its new electromechanical "Load Sentry" overload control, a new three-position controller (illustrated), and a new voltage monitor for power supplies.

For more information circle **375** on inquiry card.

Penn Instruments Div. of Burgess-Manning Co. will unveil its new Style "MN" open flow nozzle meter for measurement of flow in partially filled pipes, including a flow transmitter.

For more information circle **376** on inquiry card.

J. Bishop & Co. Platinum Works will feature new clad metals, composite wires, and small precision tubing.

For more information circle **377** on inquiry card.

Amco Engineering Co. will exhibit expandable small instrument cabinets; also two new models of air blowers which utilize a minimum of panel height.

For more information circle **378** on inquiry card.

BIG NEWS FOR EXHIBITORS!

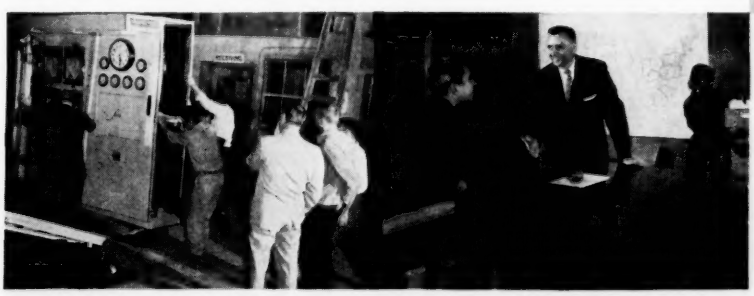
Ship Displays UNCRATED via North American Padded Vans!

Save time, trouble, expense. Ship your displays—uncrated—via North American *padded* vans! Displays arrive on time; over $1500 worth of protective equipment assures safe "factory-fresh" arrival.

North American service gives door-to-door delivery . . . eliminates local drayage . . . provides storage facilities—and exhibits can be routed from one show to another on fast, tight schedules. Call your local North American agent, or write for Free Display Moving Brochure.

COMPANY-TRAINED DRIVERS ASSURE FAST, SAFE SERVICE

At North American's world headquarters in Fort Wayne, drivers learn to handle exhibits of every size in NAVL padded vans, saving time and money for exhibitors.



Over 1100 local North American agents provide dependable exhibit display service . . . at both origin and destination.

North American Exhibit Display Division assures maintaining of set schedules for touring exhibits, too!

WORLD-WIDE SERVICE via LAND, SEA, AIR

"WIFE-APPROVED" MOVES

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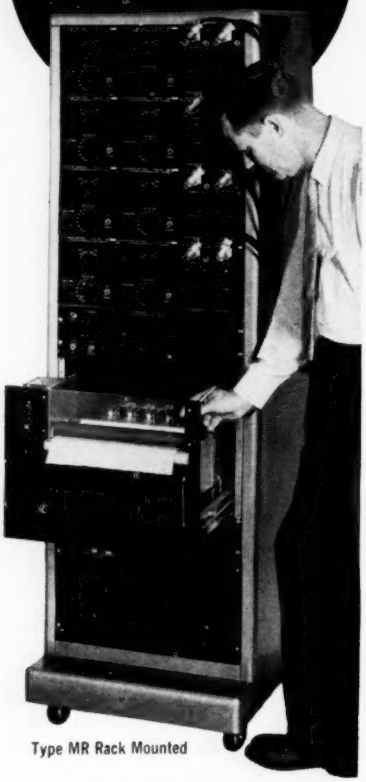
For more information circle **79** on inquiry card.

OFFNER

DYNOGRAPH



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DIRECT WRITING OSCILLOGRAPH

unequalled for versatility and performance!

- . . . rectilinear recording
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IN A SINGLE RECORDER!

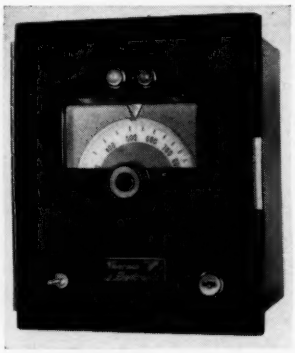
Write for 12 page, 2 color catalog—gives details and specifications.

OFFNER ELECTRONICS

5326 N. KEDZIE AVE. • CHICAGO 25, ILL.

For more information circle **80** on inquiry card.

SHOW PRODUCTS—Cont.



Thermo Electric's principal entry into the new product array is a transistorized temperature controller (shown). Other new products include the "Mini-Mite" portable indicator, a miniature self-balancing pyrometer indicator, and a variable voltage supply unit.

For more information circle **379** on inquiry card.

Schlumberger Well Surveying Corp. will display its new NMR high-speed moisture analyzer (Model 104).

For more information circle **380** on inquiry card.

WacLine will disclose development of a new flat pancake-type tachometer and new 3½" hermetically-sealed moving-coil instruments.

For more information circle **381** on inquiry card.

Triplett's Model 10 clamp-on adapter for its volt-ohm-milliameter enables testing of every current-carrying circuit.

For more information circle **382** on inquiry card.

Taller & Cooper's data integrator and converter processes pre-punched cards and permits the addition of variable information to a tape.

For more information circle **383** on inquiry card.

Magnetic Research Corp. will have the first showing of its 1000-watt magnetic servo amplifier with response of less than 30 milliseconds.

For more information circle **384** on inquiry card.

Industrial Timer Corp. will display the newly re-designed punched-card programmer with three sections: scanner, dual timer, and relay bank.

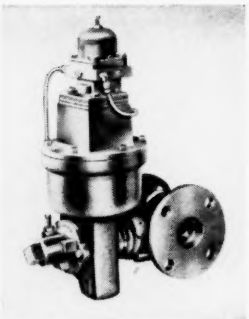
For more information circle **385** on inquiry card.

Revere Corp. of America will have impeller flowmeters, optical level control switches, strain gage load cells, and "Glaswitch" relays among its new products at the show.

For more information circle **386** on inquiry card.

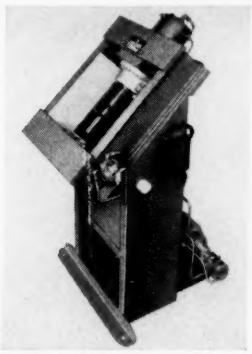
Philips Electronics will feature the first showing of its new contact, and projection microcardiographic units, respectively.

For more information circle **387** on inquiry card.



DeZurik Corp. will exhibit its new eccentric resilient-faced plug valve.

For more information circle **388** on inquiry card.



Weatherhead Co. will have its new 45° angle swaging machine for the first time on display.

For more information circle **389** on inquiry card.

Blue M Electric Co. will show the new full-range-controlled relative humidity cabinet.

For more information circle **390** on inquiry card.

Superior Tube Co. will feature its new "super-alloy" tubing for high-temperature service.

For more information circle **391** on inquiry card.

Mycalex Corp. of America will have "Supramica" ceramoplastics, "Synthamica" synthetic mica, and "Mycalex" glass-bonded mica on display.

For more information circle **392** on inquiry card.

The Technicon Co.'s Autoanalyzer provides continuous control of process streams by chemical analysis.

For more information circle **393** on inquiry card.

Skinner Chuck Co. will feature a display which will answer automatically technical questions by lighting up a panel and illustrating answers with photographs.

For more information circle **394** on inquiry card.

Veeder Root, Inc. will show new electrical high-speed counters for instruments, remote process control, data processing, predetermined batch counting, etc.

For more information circle **395** on inquiry card.

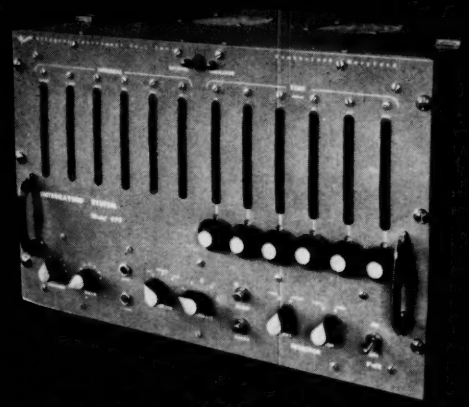
Claud S. Gordon Co. will show its latest development of bonded staple yarn which withstands 1600°F.

For more information circle **396** on inquiry card.

Ralph N. Brodie Co. will show its new shock-free "Quantrol" valve for air, liquids or gas. Operation is by line-pressure differential.

For more information circle **397** on inquiry card.

TIME AND INTEGRAL *displayed instantly*

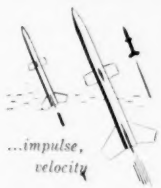


by the ALINCO model 270 Integrating System

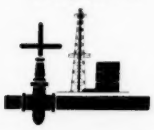
...power, average stress

THERE'S no need for planimeters or tedious arithmetic when you use the all-electronic Model 270. Designed to compute time integrals in studies of transient phenomena and in statistical quality control, the Model 270 counts at the rate of 10,000 per second. With such resolution, rapidly changing phenomena as short as 10 milliseconds in duration can be integrated to a higher degree of accuracy than heretofore possible. Convert *any* phenomenon—torque, stress, velocity, pressure, force, flow, acceleration, etc.—to a d.c. analog signal and feed it to the Model 270. Counting begins by preset signal level or by closing contacts, and stops by signal decay or by preset time (in increments of 0.0001 sec.). When the test is finished, both time and total integral are displayed on twelve digital counters. The answer often represents a ten-fold increase in accuracy over other integrating methods, and you have it *immediately,* whether your test is in the lab or out in the field. Remember, too, that ALINCO supplies a variety of high-performance instruments which can speed your projects to completion with the highest accuracies obtainable. Send for detailed literature on these guaranteed, field-proven instruments.

...impulse, velocity



...quantity, average pressure



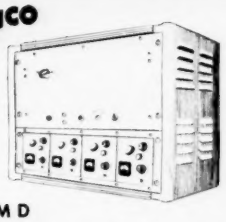
...distance

...energy

ALINCO

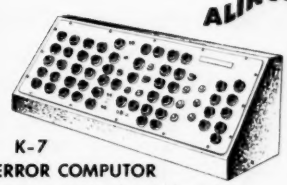
TYPE C CALIBRATOR
to calibrate load and pressure cells

ALINCO



SYSTEM D
galvanometer amplification system

ALINCO



K-7 ERROR COMPUTOR
gives magnitude and location of transducer system error

ALINCO *ALLEGANY INSTRUMENT CO. INC.*

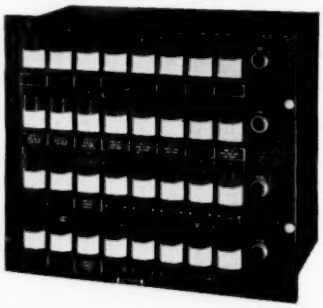
EASTERN DIVISION:
1091 Wills Mountain
Cumberland, Maryland

WESTERN DIVISION:
1052 West 6th Street
Los Angeles 17, Cal.

For more information circle **81** on inquiry card.

ANNUNCIATORS
and Accessories

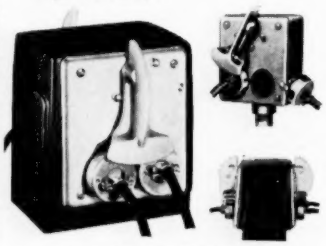
Imagineered by
TEL-ALARM



"UNITIZED CONSTRUCTION"
FOR EVERY PURPOSE

Hermetically-sealed
General purpose
Explosion-proof

- Backlighted Name Plates
- Turret Lenses
- Bull's eye



Heavy-Duty
SAFE-LOCK RECEPTACLES

For hazardous and explosive areas . . . and all general purpose applications.

Heavy-Duty
MERCURY SAFETY SWITCHES

For hazardous and corrosive atmospheres and all general purpose applications.

MOTOR
DRIVEN
FLASHERS

with mercury switch interrupters

Write for Descriptive Bulletins

Tigerman Engineering
COMPANY

4332 North Western Avenue
Chicago 18, Illinois

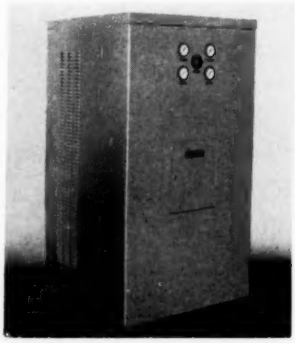
For more information circle **82** on inquiry card.

SHOW PRODUCTS—Cont.

Hickok Electrical Instrument Co. will feature its new "Cardmatic" tube testing machine, Model 123A, and the new industrial VOM, Model 455.
For more information circle **398** on inquiry card.

Diehl Manufacturing Co. will exhibit a new phase shifter, besides showing its line of a-c and d-c servo motors, tachometers, and precision resolvers.
For more information circle **399** on inquiry card.

Federal Telephone and Radio Co. will have on display large-screen oscilloscopes, a swept-frequency generator for automatic testing, the new 40-channel bar graph oscilloscope, impedance measuring equipment, and decade frequency measuring systems.
For more information circle **400** on inquiry card.

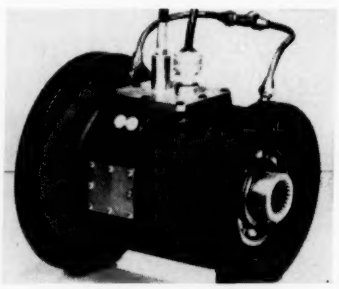


Trinity Equipment Corp. will unveil it's "Industrol Heatless Drier," a unit capable of delivering air or gas at effluent dewpoints of −100°F and below at line pressure.
For more information circle **401** on inquiry card.

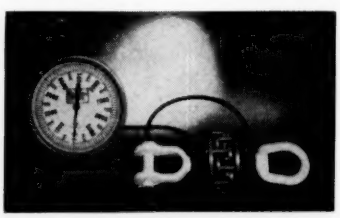
Wilbur B. Driver Co. will display its new alloys for electrical resistance, electronic, chemical, and mechanical applications.
For more information circle **402** on inquiry card.

Servo-Tek will show a new adjustable-speed drive in sub-fractional hp range, and the "Speedvolter" multimeter and portable tachometer.
For more information circle **403** on inquiry card.

Farris Pickering Governor Co. will show its new 3300 governor.
For more information circle **404** on inquiry card.



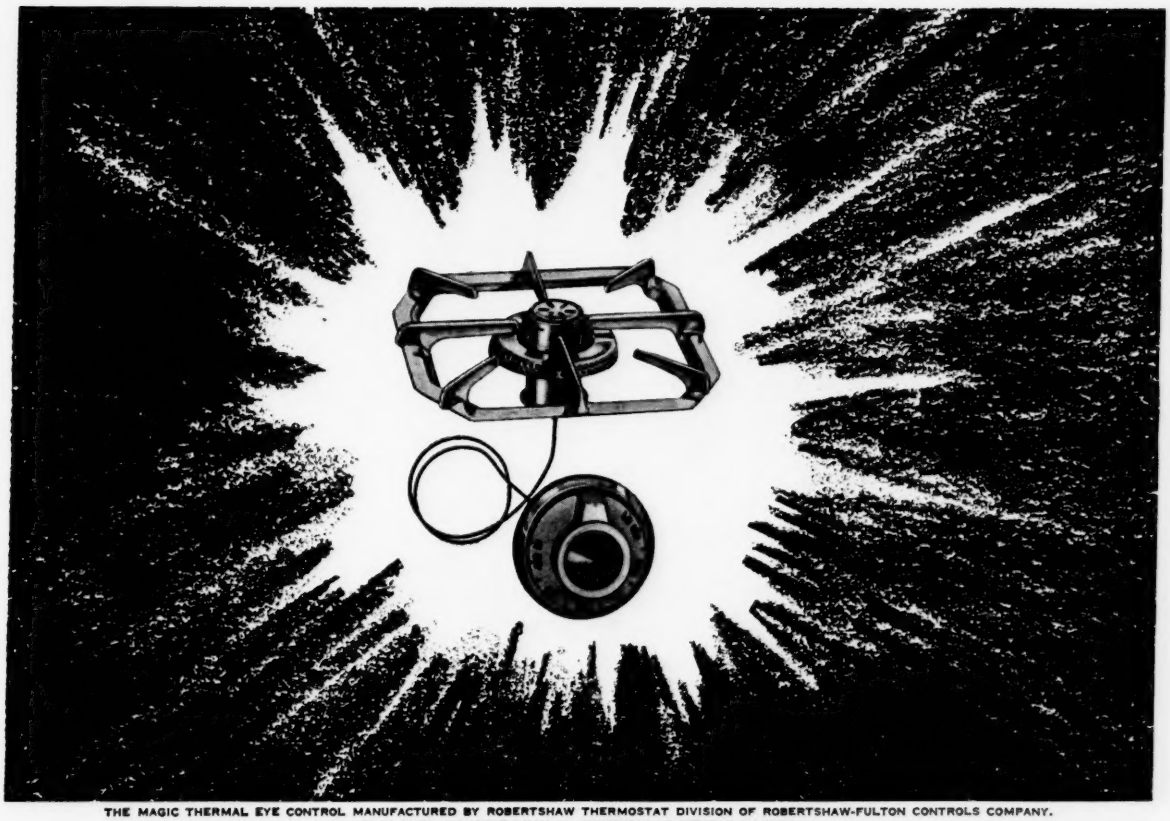
B & F Instruments, Inc. will display new torque meter systems (illustrated), automatic calibrating bridge units, accelerometers, and strain measuring and recording systems.
For more information circle **405** on inquiry card.



Among the **Martin-Decker** load measuring equipment will be this new tension load cell with indicating gage.
For more information circle **406** on inquiry card.

Magnaflux Corp.'s latest development the portable SO-200 "Sonizon" ultrasonic thickness meter will be shown, as well as new magnetic field meter, conductivity meter, electronic crack detector, and new electronic inspection instruments.
For more information circle **407** on inquiry card.

Electro Devices Inc. will display its new sequential annunciator for the first time.
For more information circle **408** on inquiry card.



THE MAGIC THERMAL EYE CONTROL MANUFACTURED BY ROBERTSHAW THERMOSTAT DIVISION OF ROBERTSHAW-FULTON CONTROLS COMPANY. IT IS USED ON MORE THAN 40 DIFFERENT HOUSEHOLD RANGES.

Robertshaw Controls "Help The Cook Get off the Hook!"

—With Precision-Controlled Tube by WOLVERINE

Nowadays—thanks to gas and electric thermostatic controls by Robertshaw®—it's difficult for a cook to spoil the broth or ruin the bacon because of overcooking.

Taking the guesswork out of cooking isn't easy—requires, in fact, exceptional precision in the manufacturing of the thermostatic controls. That's why, for example, Robertshaw uses small diameter Wolverine copper tube of rigidly controlled quality for the capillary of its new Thermal Eye® gas control. This highly responsive unit senses the temperature of cooking food and keeps it at a predetermined level—for many hours if necessary.

Precision control in all such instruments, say Robertshaw engineers, depends to a large extent on the built-in precision of the copper tube. This tube contains a temperature sensitive fluid, which by expansion and contraction, regulates the flow of fuel to the burner.

Proof that Wolverine copper tube meets these exacting demands is found in Robertshaw's use of "Miles of Wolverine copper tube each month".

Meeting the specialized demands of individual manufacturers such as Robertshaw is but another facet of Wolverine's continuous Tubemanship program.

When specifying tubing or tubular-shaped parts always remember that, at Wolverine, Tubemanship stands for the perfect blending of experience, research and sound engineering. Make it your "buy" word. Write for Wolverine's General Products Catalog.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
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PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

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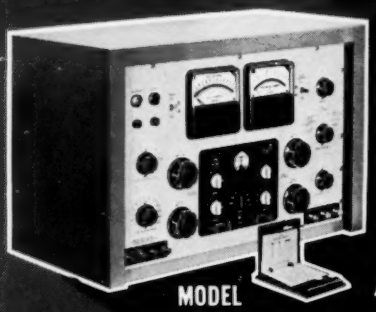
For more information circle **83** on inquiry card.

Instrument Calibration



a modern method of maintaining ACCURACY

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.

Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.

Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

Net price $15,600.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

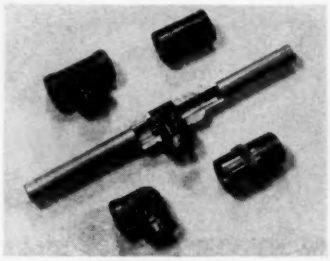
WE CAN HELP YOU

Technical and application data for our six basic models are fully described in a new 24-page catalog. Send for it today.

RFL **Radio Frequency** LABORATORIES, INC. Boonton, New Jersey, U.S.A.

For more information circle **84** on inquiry card.

SHOW PRODUCTS—Cont.

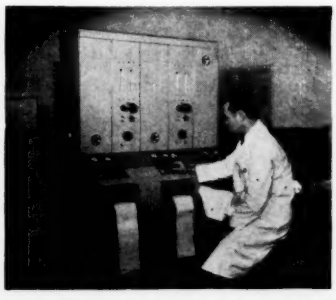


Parker Appliance Co. will show new Weld-lok welding fittings; also O-rings produced by the Rubber Products Div. shown here in a Fenwal thermoswitch.

For more information circle **409** on inquiry card.

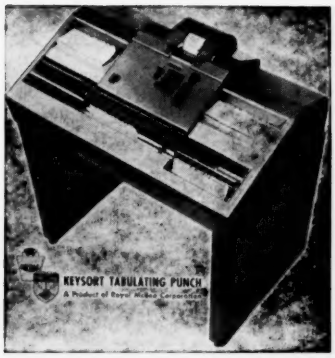
Ranarex Div. of Permutit will show gas analyzers measuring specific gravity of gases or gas mixtures.

For more information circle **410** on inquiry card.



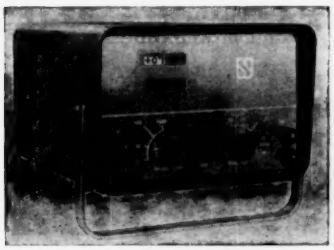
Perkin-Elmer's three divisions will exhibit new developments: The Instrument Div. will show vapor fractometers, of which a triple-stage instrument is illustrated; the Engineering and Optical Div. will exhibit new variable-focal-length lens for small television cameras, a nitrogen cryostat, and an auto-theodolite; while the Vernistat Div. will have new precision potentiometers and a non-linear function generator on display.

For more information circle **411** on inquiry card.



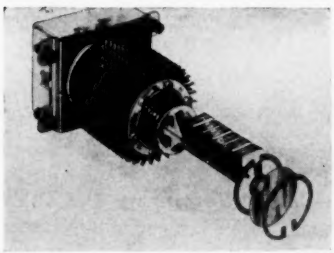
Royal McBee will show for the first time a new keysort tabulating punch (illustrated) which automatically punches and tabulates quantities and amounts in Keysort cards. The low-cost LGP-30 computer also will be demonstrated.

For more information circle **412** on inquiry card.



Union Switch & Signal's new servo-ratio multimeter shown is a highly accurate computer test instrument. Other new products to be shown at the show are digital and alpha-numerical indicators (readout devices).

For more information circle **413** on inquiry card.



Type RVF rotary switch for applications in automatic control circuitry will be shown for the first time by **North Electric Co.**

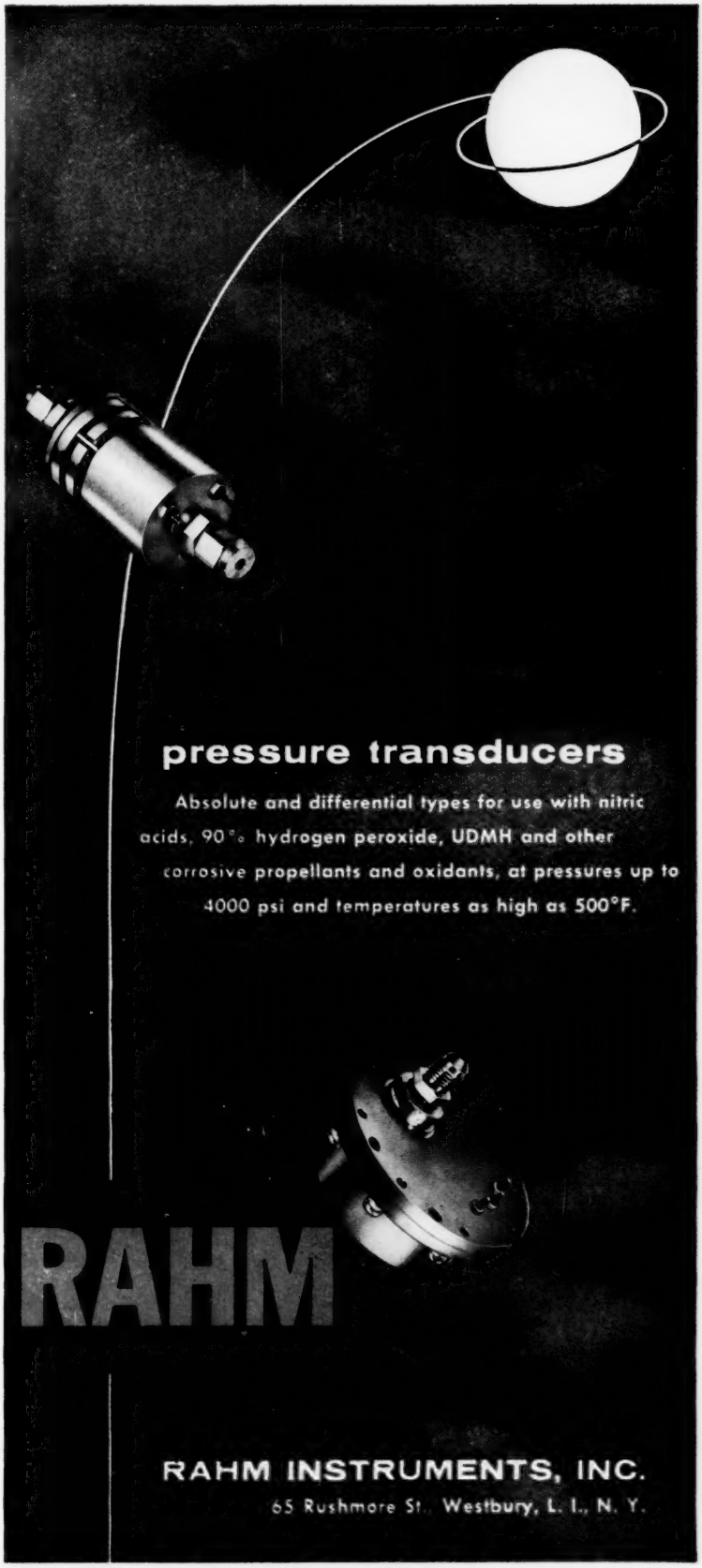
For more information circle **414** on inquiry card.

Helicoid Gage Div. of American Chain & Cable will have new gages on display.

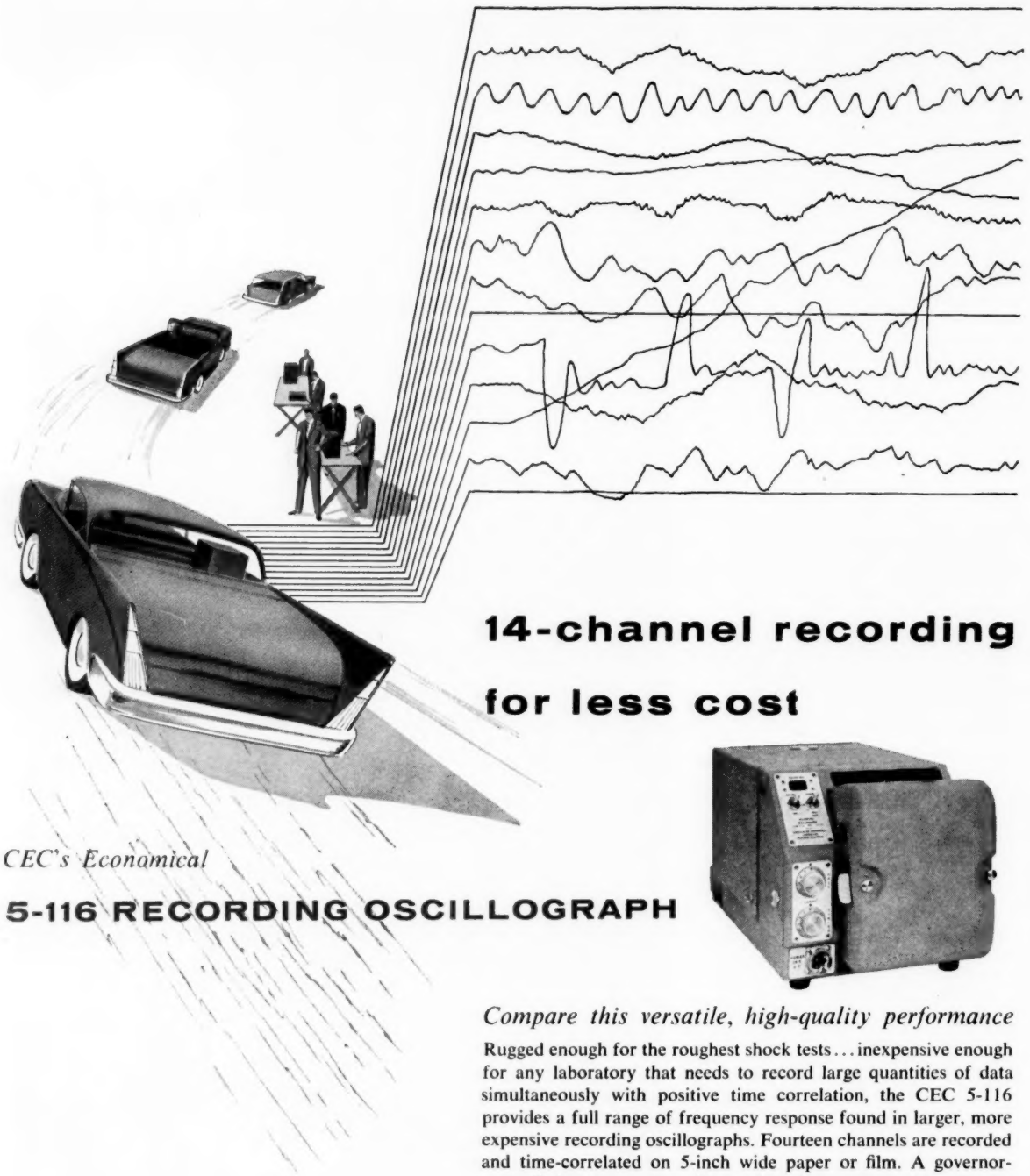
For more information circle **415** on inquiry card.

Humphrey, Inc. will unveil a new mechanical variable speed drive.

For more information circle **416** on inquiry card.


pressure transducers
Absolute and differential types for use with nitric acids, 90% hydrogen peroxide, UDMH and other corrosive propellants and oxidants, at pressures up to 4000 psi and temperatures as high as 500°F.
RAHM
RAHM INSTRUMENTS, INC.
65 Rushmore St. Westbury, L. I., N. Y.

For more information circle **85** on inquiry card.



14-channel recording for less cost

CEC's Economical

5-116 RECORDING OSCILLOGRAPH

Compare this versatile, high-quality performance

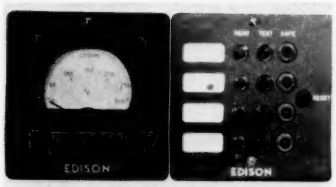
Rugged enough for the roughest shock tests... inexpensive enough for any laboratory that needs to record large quantities of data simultaneously with positive time correlation, the CEC 5-116 provides a full range of frequency response found in larger, more expensive recording oscillographs. Fourteen channels are recorded and time-correlated on 5-inch wide paper or film. A governor-controlled motor and positive quick-change gears drive the recording material at ¼" to 100"/sec. speeds. Operates from either a-c or d-c. Automatic record-numbering and trace identification are standard. For complete data, contact your nearby CEC field office, or write for Bulletin CEC 1521-X16.

Consolidated Electrodynamics

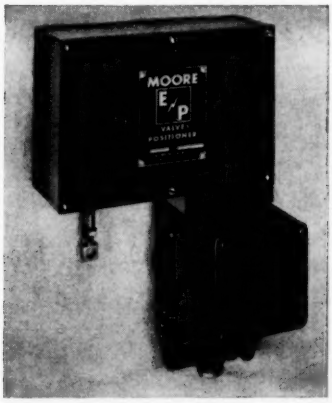
300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

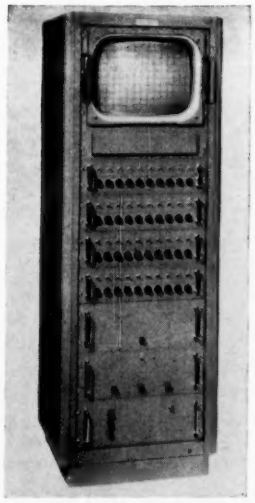
For more information circle **86** on inquiry card.



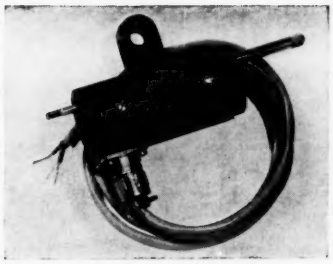
Thomas A. Edison Industries will display the new Omniguard temperature monitor.
For more information circle **417** on inquiry card.



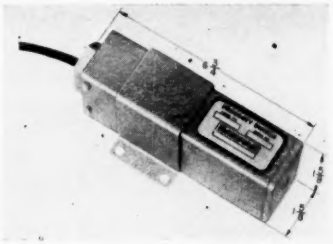
Moore Products Co. will show its new side-mounted E/P (electric-to-pneumatic) valve positioner (illustrated), and a packless flexible-shaft-type electronic liquid-level controller.
For more information circle **418** on inquiry card.



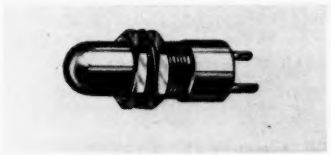
Federal Instruments, Industrial Products Div., will show its new bargraph oscilloscope that provides simultaneous display of forty separate signals as from strain gages, thermocouples, etc.
For more information circle **419** on inquiry card.



Colvin Laboratories will show its recently redesigned displacement transducer.
For more information circle **420** on inquiry card.



Among the new switches which will by displayed at **MicroSwitch Div.** of Minneapolis-Honeywell is the magnetic proximity switch which operates without mechanical actuation of any kind.
For more information circle **421** on inquiry card.



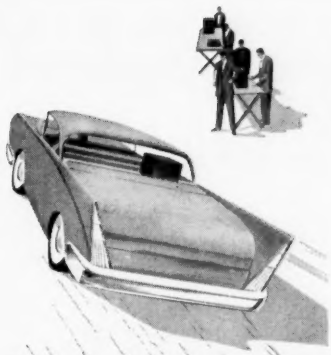
Dialight Corp. will display a new subminiature pilot light.
For more information circle **422** on inquiry card.

Van Products Co. will exhibit its new "Van Air" dehumidifier-filter for moisture control of compressed air.
For more information circle **423** on inquiry card.

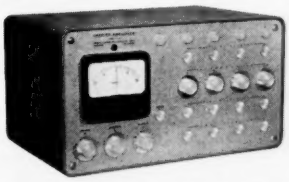
W. M. Welch Mfg. Co. will feature the first showing of its new "Densichron" duplex color densitometer.
For more information circle **424** on inquiry card.

Norcross Corp. will display its new pipeline Viscometer.
For more information circle **425** on inquiry card.

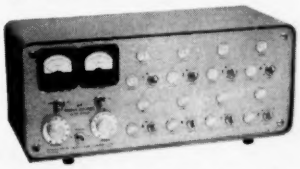
Reliance Electric and Engineering Co. will have two operating displays to show (1) the use of V-S drives with Reeves automatic speed control; and (2) the ability of the drive to maintain a preset speed regardless of load.
For more information circle **426** on inquiry card.



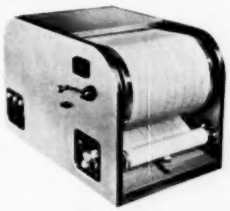
These CEC units complete your dynamic testing system...



1-118 CARRIER AMPLIFIER amplifies strain gage outputs to 600 cps with ±3% linearity. Four separate input channels may be individually adjusted to provide full-scale output from 1.875 to 64.000 mv signals. Bulletin CEC 1522-X11



8-108 BRIDGE BALANCE allows direct coupling of strain gage or other resistive-type pickups to galvanometers in a recording oscillograph. Each input channel has separate balancing and excitation-voltage adjustments. Bulletin CEC 1560-X23.



23-109 OSCILLOGRAM PROCESSOR delivers a developed and dried record at rates of 10 to 15 feet per minute. Eliminates the need for darkroom and water connections. No experience required to operate. Bulletin CEC 1537-X28.

Consolidated Electrodynamics

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Pasadena, California

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For more information circle **87** on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

CONTENTS OF THIS DEPARTMENT

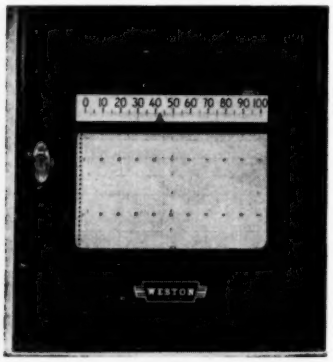
Amplifiers	1578	Electronic Components	1574	Rectifiers	1579
Capacitors	1581	Flow-rate	1549	Relays	1584
Computing	1555	Inspection	1567	Resistors	1580
Counting	1555	Laboratory Equipment	1558	Sequence	1554
Data Processing	1555	Materials	1562	Shop Equipment and Materials	1562
Dimensional Gaging	1567	Mechanical Components	1585	Speed Measurement	1553
Drafting-room Supplies	1593	Mechanical Testing	1569	Switches	1582
Electrical Components	1580	Miscellaneous	1590	Temperature	1550
Electrical Instrument Accessories	1575	Nucleonics	1561	Time	1554
Electrical Instruments	1572	Photoelectric Equipment	1552	Vacuum	1547
Electrical Testing	1570	Power Supplies	1578	Valves	1587
Electromechanical Components	1580	Pressure	1547	Volume	1549
		Process Measurement and Control	1546	Weighing	1549

FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 1621

PROCESS MEASUREMENT and CONTROL

MULTI-POINT RECORDER

New Model 6705 strip-chart multiple point recorder operates on null-balance principle, is available for re-

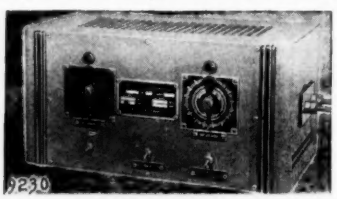


cording up to 24 points on one chart. All its components are grouped in simplest, most efficient, most serviceable manner. It features easily-changed chart speeds and a simplified method of changing printing speeds. —*Weston Electrical Instrument Corp., Newark* 12, *N. J.*

For more information circle **451** on inquiry card.

CURRENT REVERSERS

New "Periodic Reversers," from 50 amp to 3000 amp, assure better elec-

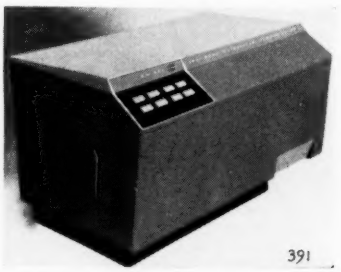


troplating by preventing nodules around burrs, build-up around corners, thin deposits at center of work, and roughness, even on rough base metals. Illustrated "Model GPR-18" features synchronous motor timers, makes possible brighter, smoother deposits requiring little or no polishing or buffing.—*Gates Electronic Co.,* 2090 *Barnes Ave., New York* 62, *N. Y.*

For more information circle **452** on inquiry card.

DIGITAL PROCESS CONTROL COMPUTER

New RW-300 makes possible on-line control of a wide variety of manufacturing processes; is fully tran-

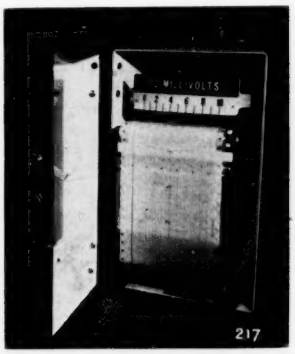


sistorized; weighs about 400 lb. When used as a central unit of a process control system, it reads process instruments, performs computations to relate readings to process objectives, determines control actions that will result in optimal plant operation, and activates process mechanisms or adjusts set points on supervised control loops.—*Ramo-Wooldridge Corp., Los Angeles* 45, *Calif.*

For more information circle **453** on inquiry card.

GENERAL-PURPOSE RECORDER

New "CH" general-purpose recorder measures and records d-c signals as

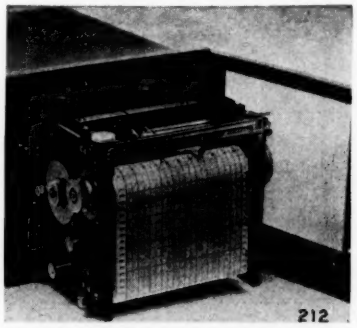


low as one millivolt full-scale; can serve also as a 5-ma recorder.—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **454** on inquiry card.

MINIATURE RECORDING POTENTIOMETER

New recording potentiometer features 2 pens, both writing margin-to-margin on a single 5" strip chart,



producing two continuous records. in less space than previously required for two 3" recorders.—*Westronics, Inc.,* 3605 *McCart, Fort Worth, Texas.*

For more information circle **455** on inquiry card.

DIFFERENTIAL PRESSURE TRANSMITTER FOR LEVEL

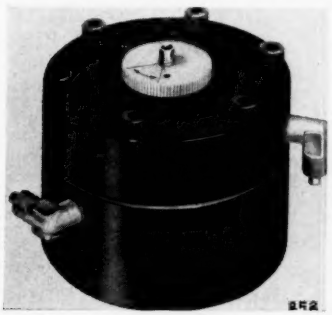
New Type 13FA d/p Cell Transmitter mounts directly on a tank nozzle to provide a simple method for measuring viscous or slurry-type liquids in open or closed vessels; operates on force balance principle and maintains calibrated accuracy over a wide range of ambient conditions. Pneumatic output is a 3-15 psi signal proportional to tank level.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **456** on inquiry card.

PRESSURE and VACUUM

PRESSURE COMPARATOR

New Precision Pressure Comparator relates an unknown pneumatic signal to a reference pressure. When



the two pressures balance, an electrical signal is sent.—*Fischer & Porter Co., 92 Jacksonville Road, Hatboro, Pa.*

For more information circle **457** on inquiry card.

PRESSURE PICKUP

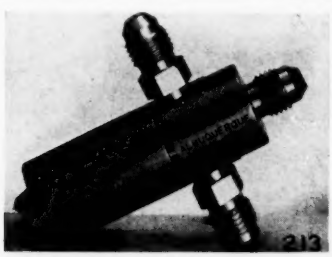
New variable-resistance-type pressure pickup adds less than 0.004 cubic inch to volume of system under

test; can be used with liquids and gases; has excellent temperature stability from −65°F to 250°F.—*Standard Controls, Inc., Seattle 44, Wash.*

For more information circle **458** on inquiry card.

PRESSURE PICKUP

New Model S-8 variable-reluctance dual-coil diaphragm-type transducer for absolute, differential, or gage



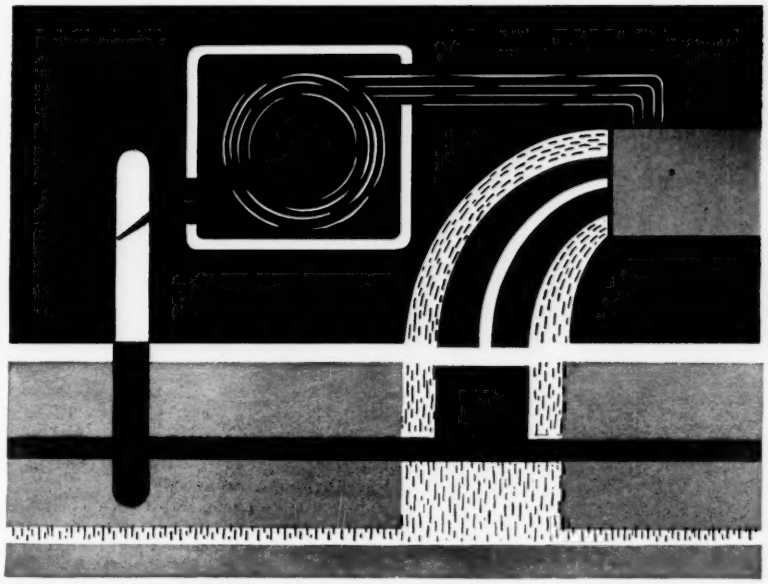
pressure is designed for rocket engine test stand studies, blast wave measurements, etc.—*Ultradyne Engineering Labs., Inc., P. O. Box 3308, Albuquerque, N. M.*

For more information circle **459** on inquiry card.

PRESSURE CONTROLLER

New Type J51 pressure-vacuum control is offered with any one of three standard switch types: normally

PNEUTRONIC *Level Control Provides Proportioning Action at Low Cost*



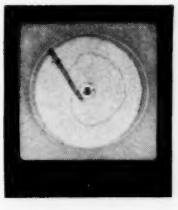
The new Fielden Pneutronic Level Control proportions flow and maintains level simply by combining an electronic "dip stick" with a proportioning pneutronic control. This dip stick has no moving parts, yet actually "senses" change in level and integrates the electronic and pneutronic units into a simple, dependable null-balance system.

Electronically, the PNEUTRONIC Level Control features the versatile electrical capacitance method of measurement. As a result, it can detect minute changes in the level of any liquid, powder, or granular solid—conducting or non-conducting. The resulting change in capacitance changes output air pressure *directly*, and this output air then feeds back to balance the electronic circuit *directly*.

FEATURES

- Null-Balance System
- Only one vacuum tube
- Control pressure 3 to 15 psi
- No moving parts in vessel
- Controls water level up to 1½" span, hydrocarbons up to 8"

SIMPLIFY RECORDING AND CONTROL WITH *Fielden*



Through interchangeable input conversion units and rebalance elements, the same basic Fielden Null-Balance Recorder can record temperature or any other process variable. Other assemblies can be added for recording up to 96 points on one circular chart, for electric control, or pneumatic proportional control. Fielden also supplies other recorders, blind on-off controllers, manual monitors, automatic scanners, and a full line of sensing elements, supplies and accessories.

Send for Literature

Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION

Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

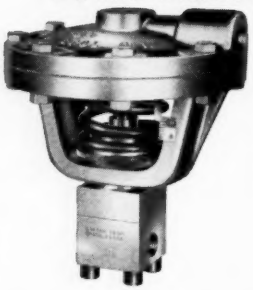
For more information circle **88** on inquiry card.

MINIATURIZATION

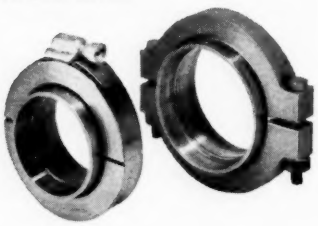
From Pilot Plant to Process

See Your Packless "Demi" Values assembled and tested, Booth 1562

12th Annual Instrument-Automation Conference & Exhibit, Cleveland Auditorium, Sept. 9-13, 1957

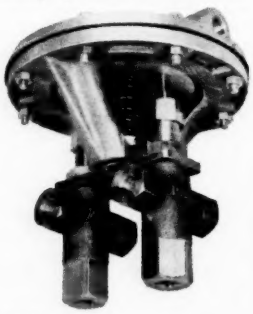


♦ "BANTAM" 500 SERIES
Throttling "Bantam" Diaphragm Control Valves for all standard control valve uses, Cv of 0.6 and below, up to 1000 psi and 500°F, characterized, renewable trim, 316 stainless steel and teflon only wetted surfaces, low in hysteresis, size and weight, a modern design of control valve. 2000 series "Bantam" Control Valves available for on-off service.

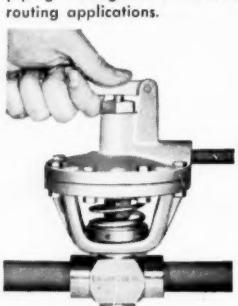


TUBE AND PIPE CONNECTORS ♦
For use in such systems as aircraft or marine applications where weight is a factor, these connectors replace standard flanges. Available in various materials, in male or female socket or butt weld design, for tubing, and up to schedule 40 pipe.

♦ "DEMI" PACKLESS VALVES
For services when packing is a problem, manifolding of small valves in one unit, these low cost valves have a great popularity. For services up to 1500 psi and 500°F., screw, toggle, or diaphragm operated, the "Demi" line is ideal for panel mounting up to five valves in one block.



WHIFFLETREE OPERATOR ♦
Two valves operated simultaneously by one operator. Valves may be globe or three-way and have a multitude of piping arrangements for mixing and routing applications.



♦ MANUAL RESET
Wherever control air on dangerous or toxic process flows must be blocked for safety, on air failure until manually reset, these valves insure against disaster. Standard sizes ¼" and ½" I.P.S.

SAUNDERS VALVES — AIR OPERATED ♦
Plastic valves, 2" and below, metal valves 1" and below, G. W. Dahl Company, Inc. diaphragm operators on these valves provide simple, sure automatic operation. Each application must submit full flow information.

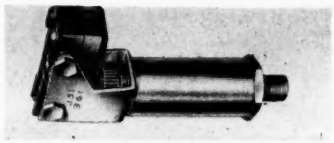
Write us for complete technical information, or the address of our representative in your area.

George W. DAHL Company

BRISTOL, RHODE ISLAND

For more information circle **89** on inquiry card.

NEW INSTRUMENTS



open, normally closed, or double throw with no neutral position. Switches are rated up to 15 amp at 115 or 230 vac. (Also available are other switches.)—*United Electric Controls Company, 79 School Street, Watertown, Mass.*

For more information circle **460** on inquiry card.

MANOMETER

New Gasco Ideal Direct Reading Manometer, for direct reading of pressure, vacuum and differential, features self-contained fluid; nonbreakable precision plastic; light weight; special cap retains reading when desired.—*Gas Appliance Specialties Co., Inc., Dept. T-26, 32-37 56 Street, Woodside, N. Y.*

For more information circle **461** on inquiry card.

PRESSURE REGULATOR

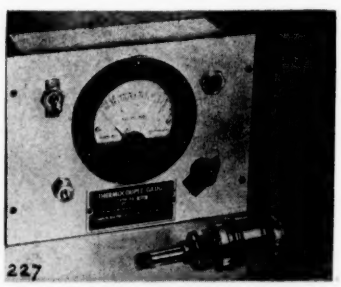
New Cartesian Manostat #6A provides automatic and vacuum pressure control; is designed with toggle valve as an integral part, assuring absolute tightness of set pressure. Once a vacuum has been set in instrument, system can be shut down without disturbing setting.—*Manostat Corp., 20-26 N. Moore St., New York 13, N. Y.*

304

For more information circle **462** on inquiry card.

VACUUM GAGE

New TG-025 single-station panel-mounted thermocouple vacuum gage operates on two size "D" flashlight



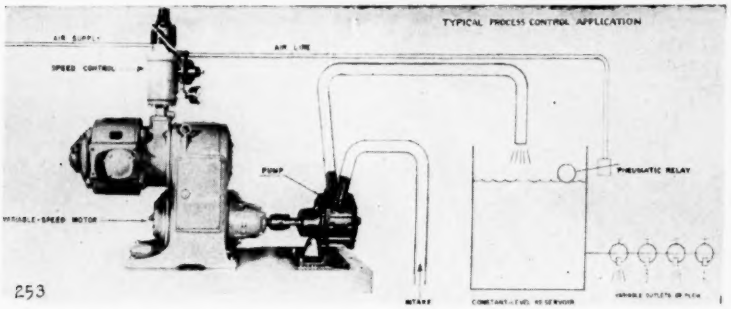
227

batteries contained within its housing. Range 0-1000 microns Hg with 0-60 microns Hg covering more than half of scale.—*Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, New York.*

For more information circle **463** on inquiry card.

FLOW-RATE, VOLUME and WEIGHT

VARIABLE-RATE PUMP-MOTOR SET

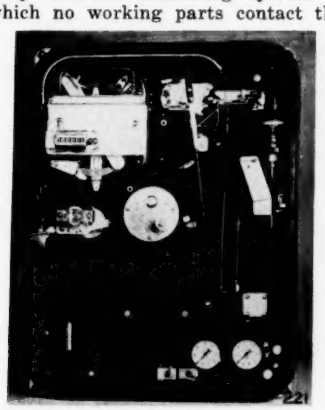


New variable-flow-rate pump-motor set is designed specifically for pilot plant, laboratory or process work involving corrosive fluids and abrasive slurries. Among means of obtaining variable speeds: v-s motor drive with provision for automatic process control using standard 3-15-psi air signal. Fluid conveyed is in contact only with unique flex-i-liner and body block. Nearly 700 combinations of plastic and natural and synthetic rubber materials.—*Vanton Pump & Equipment Corp., Hillside, N. J.*

For more information circle **464** on inquiry card.

RING BALANCE METER

New ring balance meter features fully enclosed measuring system in which no working parts contact the

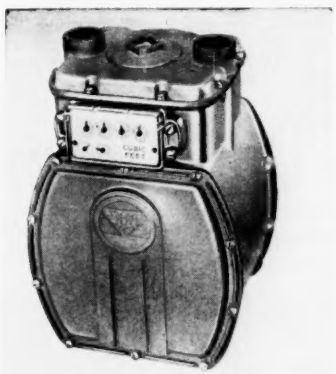


measured fluid. Complete series of measuring elements for full scale range from 0.5″ WC at 5 psig to 560″ WC at 6,000 psig, or 140″ WC at 15,000 psig, are available. Dead weight checking without disconnecting meter piping can be done.—*Hagan Chemicals & Controls Inc., 323 Fourth Ave., Pittsburgh, Pa.*

For more information circle **465** on inquiry card.

GAS METER

New Model AL-250 Slow-Speed Aluminumcase Meter operates at only 7 revolutions per cubic foot, making



it capable of sustained accuracy through greater power and slow-speed operation, insures minimum wear at vital bearing points. Rated capacity 250 cfh of 0.64 sp gr gas at ½″ w. c. differential and 5 psi rated working pressure.—*American Meter Co., Inc., 920 Payne Ave., Erie 6, Penna.*

For more information circle **467** on inquiry card.

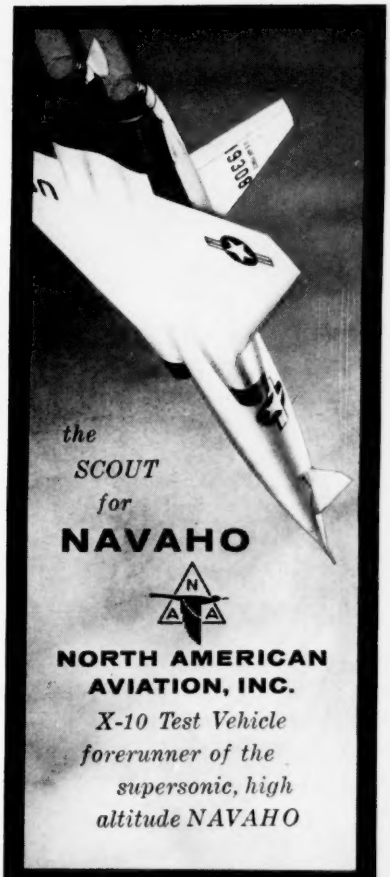
WEIGHT METER

New modified Conveyoflo Meter adapts easily to precision gravimetric feeding, or to pacing allied equipment in blending or proportioning processes. Accuracy within 0.5% of full scale over a 10-to-1 range; accurate response to rapid load variations.—*Builders-Providence, Inc., 345 Harris Avenue, Providence 1, R. I.*

For more information circle **466** on inquiry card.

MASS FLOWMETERS

New Inertial Mass Flowmeters weigh a liquid or a gas continuously as it flows through a pipe. Three types: (1) for liquids having sp gr from 0.2 to 1.5; principle: fluid passing through transmitter is given a constant angular momentum by an impeller; then this momentum is absorbed by a measuring turbine; resultant torque—proportional to mass



IN THE X-10,
Statham transducers gathered pressure and acceleration data in North American Aviation's program to prove out the aerodynamic design as well as the guidance and control systems for NAVAHO.

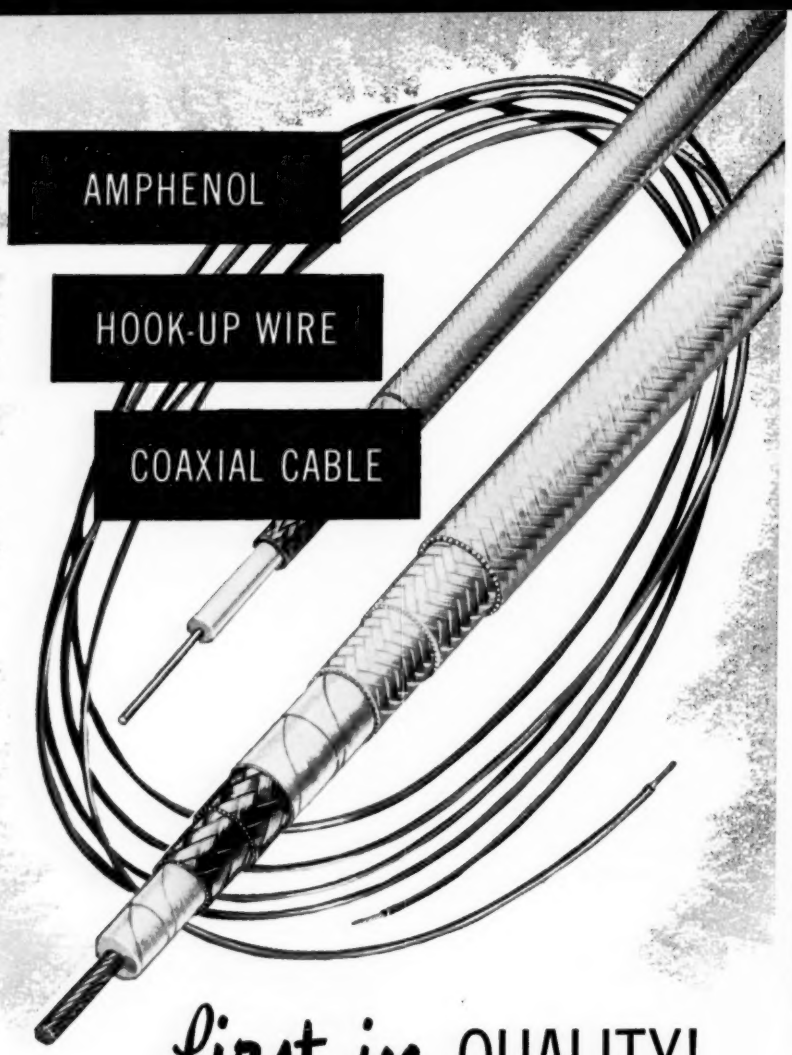
WHEN THE NEED IS TO KNOW...FOR SURE SPECIFY STATHAM

Accelerometers
Pressure Transducers
Load Cells

Catalog, complete with prices, available upon request.

Statham
LABORATORIES
LOS ANGELES 64, CALIFORNIA

For more information circle **107** on inquiry card.



first in QUALITY!

To its large family of Teflon* cables AMPHENOL now adds high temperature Teflon Hook-Up Wire. Made to the same high standards of quality, AMPHENOL Hook-Up Wire provides these reliability features:

CONCENTRICITY of Teflon insulation over tightly stranded wire—wire won't be scraped or unstranded during processing

40 MICROINCHES SILVER PLATING minimum on all wires—free from dirt or oxide for easier tinning

100% INSPECTION of every foot produced—11 Major Quality checks during manufacture

MADE TO MIL-W-16878B in types E and EE—wide variety of colors and gauges

For the *most reliable wire product* available, specify AMPHENOL's new Teflon Hook-Up Wire!

*E. I. DuPont Registered Trademark

AMPHENOL ELECTRONICS CORPORATION chicago 50, illinois
AMPHENOL CANADA LIMITED toronto 9, ontario
For more information circle 91 on inquiry card.

NEW INSTRUMENTS

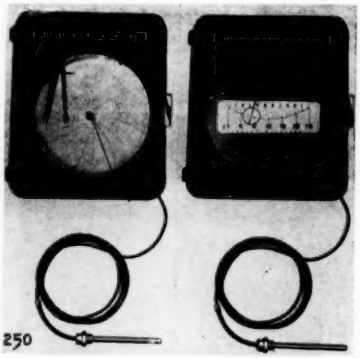
flow-rate—deflects a calibrated spring, whose deflection is converted into an electrical voltage ratio. Models available for airborne use and for test labs. (2) In type for gases, transmitter uses null-balance principle: a constant restraining torque is applied to measuring turbine and impeller's speed is automatically adjusted to balance; pulse generator is mounted on impeller; pulse frequency is transmitted. (3) Type for extreme temperatures has driven turbine restrained by a mass suspended on an arm: as temperature changes, change in arm length compensates for change in pipe diameter.—*Inertial Instruments, Inc., 1738 Colorado Ave., Santa Monica, Calif.*

For more information circle **468** on inquiry card.

TEMPERATURE

TEMPERATURE INSTRUMENTS

New 4000 Series includes recorders, recorder-controllers, indicators and

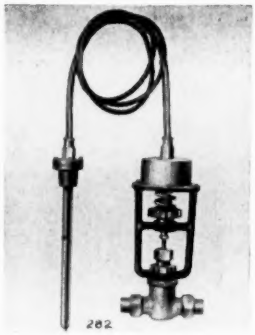


indicator-controllers, features uniform accuracy over entire scale.—*Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.*

For more information circle **469** on inquiry card.

TEMPERATURE REGULATORS

New 155 Series Direct Acting Regulators maintain liquid temperature by controlling heating source; new 157 Series Reverse Acting Regulators (157 Series) maintain liquid temper-



ature by controlling cooling source. Both types adjust for temperature control within a 40 F° operating range between 100°F and 240°F.—*Watts Regulator Co., Industrial Division, Lawrence, Mass.*

For more information circle **470** on inquiry card.

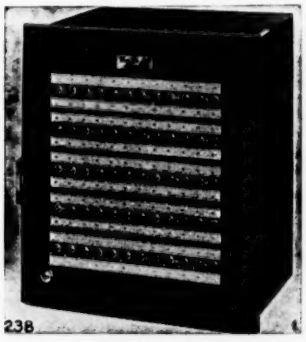
THERMOCOUPLE SYSTEM CALIBRATOR

New "Model TC2 Thermocouple Control Unit," for temperature calibration and sensitivity adjustment in multi-channel recording systems, couples as many as 12 TC measuring circuits, each to its recording element (usually an oscillograph galvanometer), and provides for injection of known voltages to produce temperature calibration traces. A reference temperature base is also provided through a separate "bucking" voltage source included in "Control Unit."—*Pace Engineering Co.*, 6914 *Beck Ave., North Hollywood, Calif.*

For more information circle **471** on inquiry card.

SWITCHES FOR PYROMETRY CIRCUITS

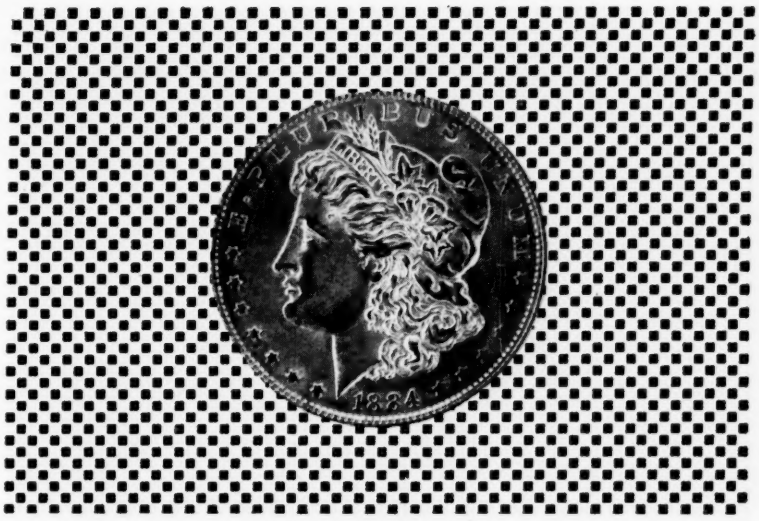
New switches provide users with versatile means of connecting sensing elements to indicators, recorders or other instruments.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*



For more information circle **472** on inquiry card.

MINIATURE COLD JUNCTION

New "AutoRef" miniature reference junction unit, of compensating bridge type design, provides constant-temperature reference at TC cold junctions; is said to be the first reference junction unit to satisfy the important requirements of small size (1¼" x 2⅝" x 3"), light weight (12



more points per dollar

Expanded scale readings . . . increased sensitivity

Inclined manometers give expanded scales, greater sensitivity and greater readable accuracy to any measurement application. Note the comparison of scale lengths for vertical and inclined manometers of equivalent ranges. It demonstrates just one phase of the versatility you have when you know and use manometer instrumentation.

With manometers, the same budget will cover more points of measurement on your flow chart . . . AND at each point, you will get *more* accuracy, *more* readability, *more* dependability.

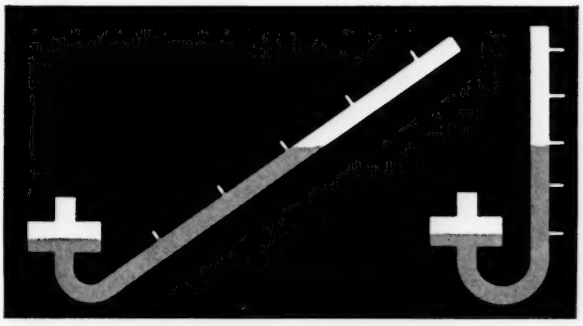
Where else can you find the lowest cost instrument with the highest accuracy rating?

—or a rugged industrial instrument which inherently possesses test laboratory accuracy and elegance?

—and whose performance is right out in the open . . . literally verified before your eyes?

Dollar conscious all the way, a manometer costs next to nothing to maintain and absolutely nothing to operate.

Bulletin G-14, an informative guide to manometers, is yours for the asking:
The Meriam Instrument Co., 10920 Madison Avenue, Cleveland 2, Ohio.



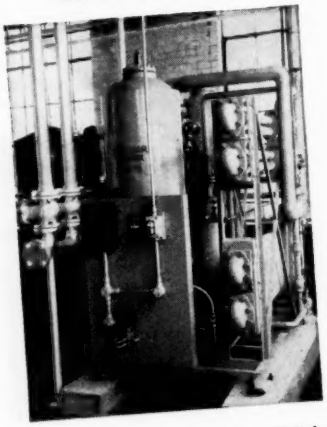
FLOWS · PRESSURES · VACUUMS · LEVELS · DIFFERENTIALS

MERIAM MANOMETERS
...always accurate

For more information circle **92** on inquiry card.

To: Pete Williams - Plant Supt.
From: Bob Porter
You wanted to know how we keep our instruments and control air lines from fouling up. Here is the answer:

For Efficient LOW-COST Drying of Instrument and Control Air Choose a Pritchard HYDRYER®



Many exclusive features of the Pritchard HYDRYER make it ideal for low-cost drying of instrument air as well as compressed air for air control systems. Features such as:

- NO WASTE—100% of all air entering the HYDRYER is dried without loss.
- FULL LINE PRESSURE REACTIVATION—Pressuring and depressuring of adsorbers between cycles is eliminated.
- NO PURGING—The Type A HYDRYER uses inlet main air stream for reactivation.
- LONGER ADSORBENT LIFE.
- NO MOVING PARTS.
- SIMPLIFIED OPERATION.
- REDUCED EQUIPMENT AND LINE SIZES.

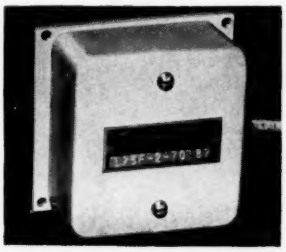
. . . and many other proved advantages.

You can get all the facts by writing for Hydryer Bulletin No. 16.0.081. write to

J.F. PRITCHARD & COMPANY of CALIFORNIA
Dept. 592, 4625 Roanoke Parkway
Kansas City 12, Missouri

For more information circle **93** on inquiry card.

NEW INSTRUMENTS



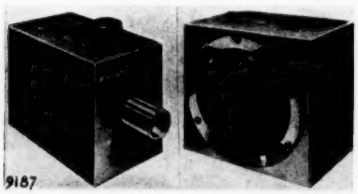
oz), and resistance to severe conditions of shock and vibration.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **473** on inquiry card.

PHOTOELECTRIC EQUIPMENT

PHOTOELECTRIC SYSTEM

New low-cast "Photoelectronic system Kit" comprises an extremely sensitive photoelectronic relay, a power-



ful long-distance light source, step-by-step instructions and giant-size pictorial diagrams; is easy to assemble. Terminals on relay housing can be used to provide 6.3 v to power device to be controlled by relay. Light-source kit includes a sealed-beam bulb and infrared filter. —*Allied Radio Corp.*, 100 *N. Western Ave., Chicago* 80, *Ill.*

For more information circle **474** on inquiry card.

PHOTOELECTRIC-SYSTEM LIGHT-SOURCE

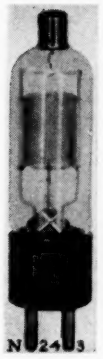
New "Model 6300" high-efficiency projector for photoelectric applications features small size, long bulb

life, projection distances up to 8 ft., and simple lens system used in conjunction with a confined 4-cp fila-

ment lamp. Operates on 12 v.—*Autron Engineering, Inc., 1254 W. Sixth St., Los Angeles 17, Calif.*

For more information circle **475** on inquiry card.

VACUUM PHOTOTUBE



New "CE-75V" low-dark-current high-sensitivity vacuum phototube, developed for instrumentation work, has a maximum dark current rating of 5×10^{-11} amp. All internal parts are electropolished in order to minimize dark current. Bulb and base have also been silicone treated to minimize external leakage. Peak sensitivity of S1 surface is at 0.8 micron. New tube may prove valuable in many applications besides instruments.—*Continental Electric Co., 6 N. Michigan Ave., Chicago 2, Ill.*

For more information circle **476** on inquiry card.

SPEED

MOTOR-TAC GENERATOR

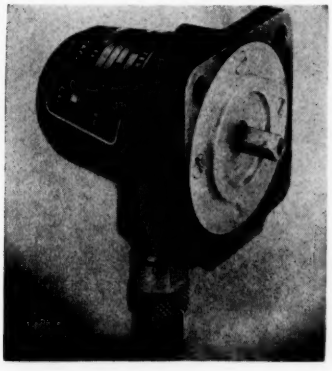
New Type 10-MTG-6229-15 high-temperature miniature motor-tachometer generator, with low output-to-

null ratio, operates continuously in an ambient temperature range of −55°C to 125°C.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **477** on inquiry card.

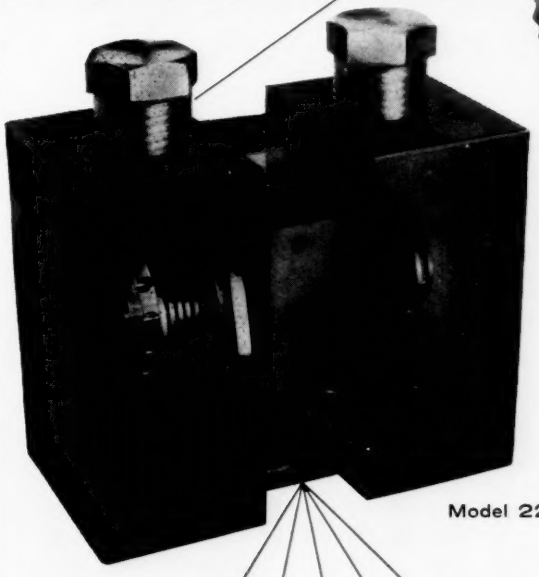
DIGITAL TAC GENERATOR

New digital tachometer has been accepted for guided missiles, plus a wide range of industrial uses. Ac-



THINK MODERN!

insist on **BARTON 224**
DIFFERENTIAL PRESSURE UNIT
when specifying your instrumentation



small
3" x 4" x 3"

light
under 8 lbs.

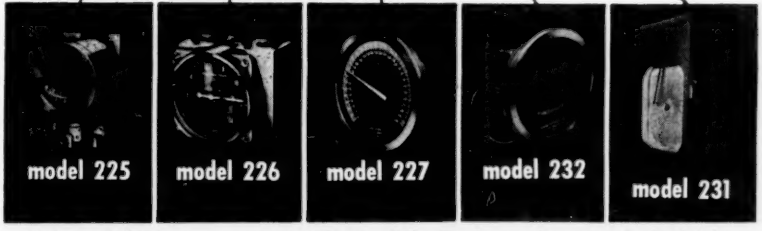
rugged
portable, versatile

accurate
stable, reliable

Model 224

The Model 224 like the well known Model 199 incorporates the patented Barton Rupture Proof Bellows principle and can withstand over-ranges up to the pressure rating of the housing regardless of the differential pressure range of the unit. This unit obsoletes the lubricated pressure tight bearing, by transmitting bellows motion to the exterior of the housing through a torque tube. With differential pressure ranges from 0-75" W.C. to 0-400 psi and housings rated from 500 psi to 3000 psi, the Model 224 offers a maximum of flexibility and utility.

Available in five basic models.



Refer to Bulletin 224-1 or contact Barton Sales Engineers in most principal cities.

BARTON INSTRUMENT CORPORATION

580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

For more information circle **94** on inquiry card.

Between Concept and Configuration

...Save Time and Money with

PHILBRICK PLUG-IN DC

AMPLIFIERS

AVAILABLE FROM STOCK

For a wide variety of instrumentation and control problems, you can facilitate rapid set-up with either one or both of these octal-based, plug-in Philbrick Amplifiers. Operational Amplifier, Model K2-W, features balanced differential inputs for minimum drift and maximum utility. In conventional applications, overall amplifier characteristics are affected solely by the feed-back networks, since the two inputs can be maintained at nearly equal potential with appropriate feed-back circuitry.

For more critical applications where long term drift must be reduced to sub-millivolt levels, Stabilizing Amplifier, Model K2-P, is paired with Model K2-W. *Write for free 28 page Plug-In Amplifier Applications Manual-12.*

MODEL K2-W	MODEL K2-P
GAIN: 15,000 dc, Open Loop	GAIN: 1,000 dc
POWER REQUIREMENTS: 4.5ma @ ±300 vdc, 0.6 amps. @ 6.3v	POWER REQUIREMENTS: 2.4 ma @ +300 vdc, 0.45 amps. @ 6.3 vac, 60 cps
OUTPUT RANGE: +50v. to −50v. at 1 ma	INPUT IMPEDANCE: 1 Megohm
RESPONSE: 2 Microseconds rise time, 100 Kc with unity feed-back	STABILITY: Below 100 Microvolts
PRICE: $24.00 Postpaid	PRICE: $60.00 Postpaid

GEORGE A. GAP/R

PHILBRICK

RESEARCHES, INC.

230 Congress Street, Boston 10, Massachusetts HUbbard 2-3225

For more information circle **95** on inquiry card.

NEW INSTRUMENTS

curacy can be better than 0.001 rpm, with a scale of 0-10,000 rmp. Output can be by sharp pulse or sine wave with signal set −1 to 100 per revolution.—*Nacimco Products, Inc.*, 2300 *National Ave., National City, Calif.*

For more information circle **478** on inquiry card.

TIME and SEQUENCE

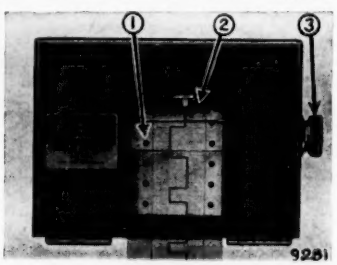
TIME METER

New A. C. Hour Log registers accumulated running time of equipment operating on ac.—*Engler Instrument Co.*, 250 *Culver Avenue, Jersey City, N.J.*

For more information circle **479** on inquiry card.

OPERATION RECORDER AND RUNNING-TIME METER

New "Model SR" of maker's previously-announced "Recorder+Totalizer" embodies these new features:



(1) sprocket-driven strip chart, (2) lift-up access window allowing making notations on chart; (3) external chart time-of-day setting knob.—*Standard Instrument Corp.*, 657 *Broadway, New York* 12, *N. Y.*

For more information circle **480** on inquiry card.

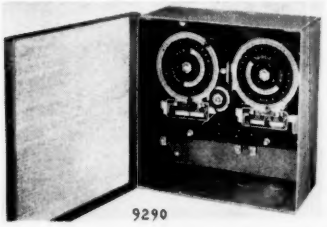
AUTOMATIC-RESET TIMER

New dc version of "Atcotrol Automatic Reset Dial Timer" differs from ac unit only in clutch relay and motor, these being wound to accommodate voltages from 6 to 250.—*Automatic Temperature Control Co., Inc.*, 5200 *Pulaski Ave., Philadelphia* 44, *Pa.*

For more information circle **481** on inquiry card.

TIME SWITCH

New "MC" ("Momentary Contact") time switch series, makes possible direct automatic control of low-voltage



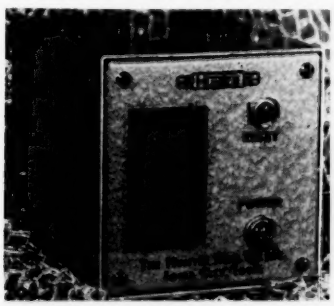
lighting systems and mechanically-held contactors; works on an entirely new time switch principle: 24-hour timing dial automatically provides a 3 to 5 second ON pulse and OFF pulse. ON-OFF times, however, are set in the same manner as on a regular time switch; tripper arms are placed at exact time required on dial.—*Tork Time Controls, Inc., Mt. Vernon, N. Y.*

For more information circle **482** on inquiry card.

COUNTING

HIGH-SPEED COUNTER

New electrically-operated counter registering up to 20 counts per second is a 4 digit counter (range from 1 to



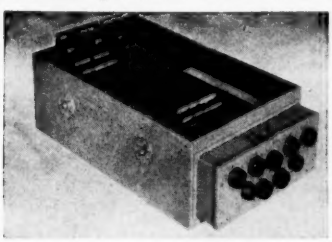
9,999) with a push button reset, both electrically operated.—*Hunter Mfg. Co., 108 S. Linn St., Iowa City, Iowa.*

For more information circle **483** on inquiry card.

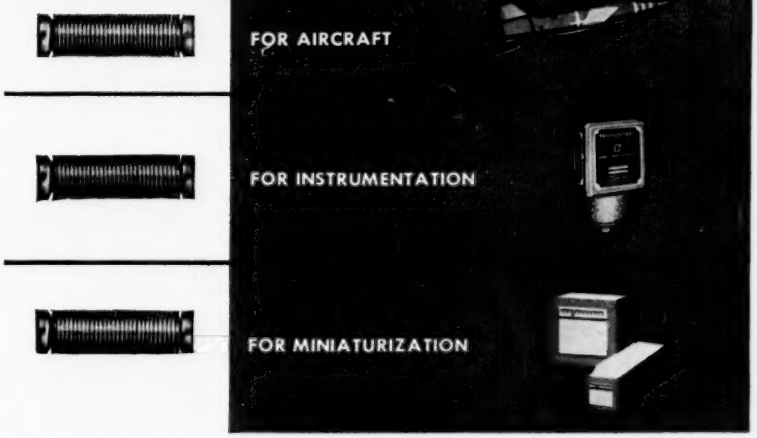
COMPUTING and DATA PROCESSING

AIRBORNE COMPUTER

New TRANSAC C-1100 Transistor Automatic Computer handles all computational problems encountered in

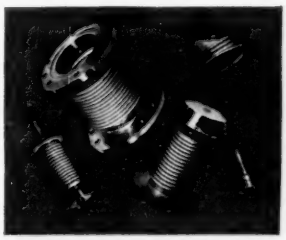


Engineering News from *Bridgeport* Thermostat



MINIATURE BELLOWS FOR INSTRUMENTS and AIRCRAFT

Save space and weight in instrument and aircraft design. Specify small-diameter seamless metal bellows. Bridgeport Thermostat's specialized experience in bellows engineering provides these tiny units as small as ¼" and 5/16" diameter, and in a wide range of characteristics and metals.



BELLOWS ASSEMBLIES

Practical savings in time, trouble and money can be made by buying complete bellows assemblies . . . let Bridgeport Thermostat show you how.

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

Send me the Bridgeport bellows data checked below: (Dept. PL-125)

☐ Full details on new, small-diameter bellows

☐ Bellows Engineering Catalog

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

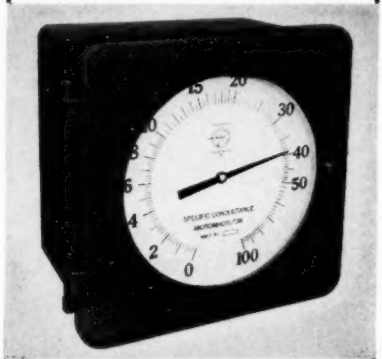
For more information circle **96** on inquiry card.

Self-Balancing

INDICATOR-CONTROLLER

Type RI

For Measurement of Electrolytic Conductivity



A COMPACT, self-balancing instrument, the RI Indicator-Controller is used for the measurement and control of solution concentrations in industrial processes not requiring recording. The exceptional flexibility of the instrument permits its use for any measurement of electrolytic conductivity from the very highest resistance of pure water and condensed steam to the low resistance of concentrated solutions of acids, alkalis and salts.

FEATURES:

- True AC Wheatstone Bridge.
- Large easily read scales.
- Plug-ins for automatic or manual temperature compensation.
- Self-balancing, responds immediately to any change in solution conductivity.
- Available as a multi-range instrument for laboratory use, replacing manual balance bridges.
- Many types of control accessories available.

Send today for catalog covering complete line of conductivity cells and instruments.

Industrial Instruments

89 Commerce Road, Cedar Grove, Essex County, New Jersey

For more information circle **97** on inquiry card.

NEW INSTRUMENTS

control of military aircraft in flight; occupies less than 4 cu ft of space. Its advent is said to be "the first significant step forward in the production of transportable high-speed data processing systems."—*Philco Corp., Government and Industrial Div.,* 4700 *Wissahickon Ave., Phila.* 44, *Pa.*

For more information circle **484** on inquiry card.

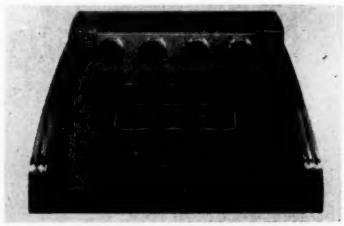
CHARACTER PRINTER

New Model D-2 or Model D-3 Character Printer, developed especially for maker's Autograf *X-Y* Recorder.—*F. L. Moseley Co.,* 409 *N. Fair Oaks Ave., Pasadena, California.*

For more information circle **485** on inquiry card.

DIGITAL TO ANALOG CONVERTER

New Digital to Analog Converter utilizes external standard voltage sources to provide outputs from four



output pots. Standard output resolution of 0.05% of full-scale is available with a ten-turn pot. Dials on front panel provide a visual readout in percent of full scale of output variables.—*Litton Industries,* 336 *N. Foothill Rd., Beverly Hills, Calif.*

For more information circle **486** on inquiry card.

MICRO DATA READER

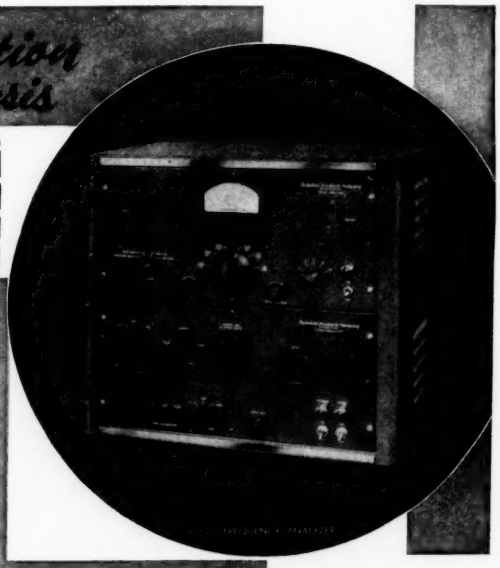
New "Micro Opaque Reader" will accept every known type of card with micro data on it; utilizes for the first

time an opaque reading screen offering greater eye-reading comfort than does conventional transluscent screen. —*American Optical Co., Instrument Div., Buffalo* 15, *N. Y.*

For more information circle **487** on inquiry card.

FOR *Vibration analysis*

THE TP-625 FREQUENCY ANALYZER



FEATURES

- **LINEAR FREQUENCY CALIBRATION** Manual or Automatic Sweep
- **EXCELLENT STABILITY** Temperature Controlled bridge-stabilized oscillator
- **CONSTANT FREQUENCY BANDWIDTH** As narrow as 2 cps; as broad as 200 cps
- **DYNAMIC RANGE** As great as 66 db (depending upon filter employed)
- **SPECTRUM** 2 cps to 25,000 cps
- **MULTICHANNEL ANALYSIS** Simultaneous analysis of numerous channels

The TP-625 Frequency Analyzer will determine the recorded frequency-amplitude spectrum of a random wave within the frequency range of 2 cps to 25,000 cps. In addition to analyzing random waves, the instrument will also determine the frequency and amplitude of the individual components in a periodic wave within this frequency range.

Wave components resulting from vibration, pressure, strain, light, etc., can be measured in decibels, in percent of total signal or both. Results are indicated on a calibrated attenuator and on a meter. For permanent, detailed analysis, high and low impedance output are provided to drive a recorder. When equipped with its accessory servo system, the TP-625 will follow RPM, or multiples of RPM, in engines throughout an operating range.

For specifications and further information, write for bulletin 625-1-956.

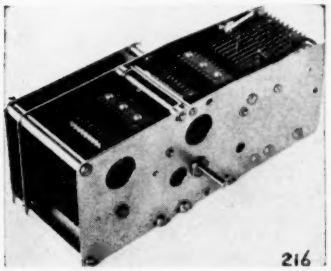
I.S.A. Exhibit - Cleveland Booth 217

Technical Products Co.
INSTRUMENT DIVISION
70 Lexington Ave. Los Angeles 38, Calif.

For more information circle **98** on inquiry card.

SHAFT-POSITION ENCODER

Three new code outputs are available with Digi-Coder, maker's shaft

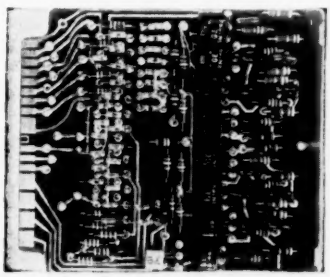


position analog-to-digital converter.—*Fischer & Porter Co., 94 Jacksonville Road, Hatboro, Pa.*

For more information circle **488** on inquiry card.

COMPUTER ELEMENTS

New transistorized plug-in computer elements packaged in the form of printed circuit cards can be used

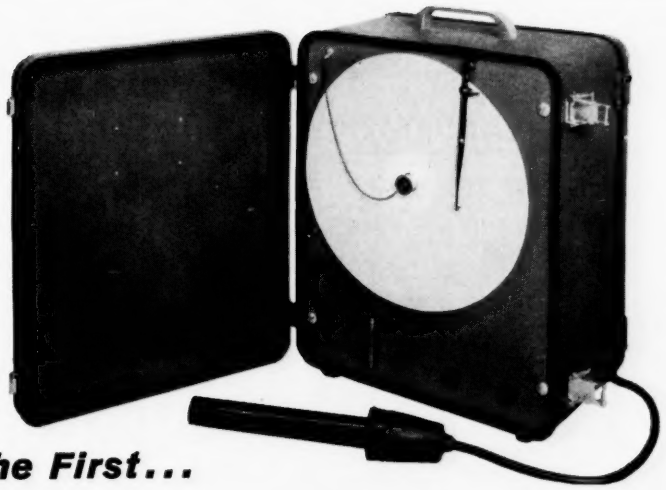


to form a compatible system with which any logic problem for computers or control may be solved. Illustrated Model 2TX Flip Flop consists of two flip flops with diode gates and amplifiers. *N-p-n* transistors are used with direct-coupled amplifiers on each side of flip flop. Output of amplifier operates diode gates directly; will supply up to 10 gates without undue loading.—*Ransom Research, P. O. Box 382, San Pedro, Calif.*

For more information circle **489** on inquiry card.

CODE DISCS

New high-accuracy nonlinear and decimal code discs for maker's analog-to-digital shaft angle encoders can be



the First...

COMPLETELY PORTABLE BATTERY-OPERATED

Electrolytic Conductivity Recorder

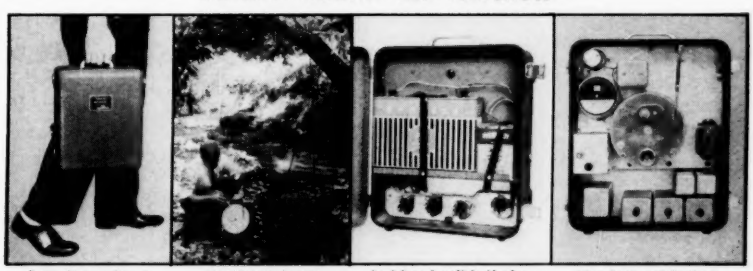
Developed especially for the purposes of recording electrolytic conductivity at locations where electrical power is unavailable, Industrial Instruments presents the first truly portable, battery-operated, Electrolytic Conductivity Recorder.

Utilizing a clock-work mechanism for the chart drive, no electrical power is consumed. All electronic portions of the recorder are completely transistorized minimizing battery drain over existing conventional units. The recorder is manufactured in a circular chart model only with a wide range of chart speeds available. AC Wheatstone bridge self-balancing principle has been incorporated into the recorder with a bridge frequency of 1000 cps.

Unique circuitry keeps the current drawn from the batteries to a figure of less than 8.0 ma when the instrument is not rebalancing and approximately 600 ma when rebalancing. Two 6 volt batteries are supplied with the instrument and are sufficient for two months of continuous operation. Numerous battery packs can be supplied in both the dry cell and rechargeable types.

The recorder is direct reading in micromhos and is available in a wide variety of ranges. Measurements of electrolytes ranging from distilled water to strong acids can be made. Can be supplied with either manual or automatic temperature compensation. Unit is housed in handsome, drawn aluminum carrying case with handle. Case is gasketed and of splash-proof construction. Size: 13⅞" high X 11⅝" wide and 9½" deep. Weight 18 (without batteries).

SEE US IN BOOTH #629 - ISA SHOW



Carry it anywhere! | Use it anywhere! | Just two 6-volt batteries for power supply. | Plug-in transistorized components.

For complete details and specifications write today to . . .

Industrial Instruments

89 COMMERCE ROAD, CEDAR GROVE, ESSEX COUNTY, NEW JERSEY

For more information circle **99** on inquiry card.

produced, if original data can be placed on IBM punched cards. Any number of divisions to 100,000.—*Baldwin Piano Co., 1801 Gilbert Avenue, Cincinnati 2, Ohio.*

For more information circle **490** on inquiry card.

LABORATORY EQUIPMENT

LABORATORY RECORDER

New multi-range vertical strip chart recorder for laboratory bench operation is an automatic self-balancing

potentiometer recorder which records as a function of time any variable that can be translated to voltage or current signals; provides 9 standard chart speeds and 40 different ranges. —*E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Illinois.*

For more information circle **491** on inquiry card.

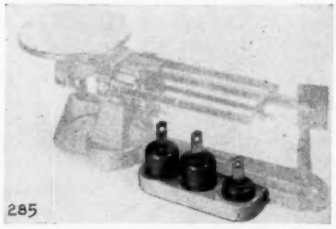
ULTRAMICROBALANCE

New "Model E" ultramicrobalance for lab analysis and research has a fused silica beam supported by a torsion fiber attached to a calibration wheel accurate to one minute of arc. Reinforced beam design and new pan support principle give great shock resistance and provide a high load safety factor.—*Microtech Services Co., Box 121, Berkeley, Calif.*

For more information circle **492** on inquiry card.

WEIGHT RACK

New convenient weight rack for use with maker's Triple Beam Balances stores a complete set of attachment weights to extend capacity from beam capacity to total capacity.—*Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J.*



For more information circle **493** on inquiry card.

BUCHNER FUNNEL

New addition to maker's line of polyethylene ware is a sturdy two-piece construction Buchner funnel. Easily cleaned; takes 70-mm filter paper (perforated plate 77 mm dia). Available from stock.—*Ace Glass Inc., Vineland, N. J.*

For more information circle **494** on inquiry card.

COLOR COMPARATOR-GRADER

New Model F Agtron, an abridged spectrophotometer originally produced for US Govt color-grading of tomato

MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

MARSHALLTOWN MANUFACTURING CO.

MARSHALLTOWN 3, IOWA

For more information circle **101** on inquiry card.

ANNOUNCING

HANKISON

MAG-PNEU-POWER Trap

PAT. PENDING

A MASTERPIECE OF DESIGN

1 MAGNETIC SNAP-ACTION operates pilot valve

2 POWER OPERATION using the energy in your pneumatic system

3 AUTOMATIC MECHANISM only TWO moving parts

PRESSURE RANGE 10-200 PSIG

Now . . . power-action condensate discharge for all compressed air and gas lines!

Write for Bulletin 501

HANKISON CORPORATION

951 BANKSVILLE ROAD · PITTSBURGH 16, PA.

HC-14

For more information circle **102** on inquiry card.

INERTIAL GUIDANCE

Few areas of engineering or science offer greater problems – or greater opportunity for achievement – than inertial guidance. At Lockheed Missile Systems, engineers and scientists are performing advanced work on all phases of inertial guidance and navigation.

New positions have been created for those possessing backgrounds in mathematics, physics, electronics, servomechanisms, flight controls, precision instrumentation and computer design. Openings are on the Sunnyvale, Palto Alto and Van Nuys staffs. Those possessing strong interest in inertial guidance are invited to write the Research and Development Staff at Sunnyvale 1, or Van Nuys 35, California.

Here R. G. Rickey (left), components specialist, discusses new accelerometer designs with E. V. Stearns, head of the Inertial Guidance Department.

Lockheed

MISSILE SYSTEMS DIVISION

LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS

CALIFORNIA

Double Metal

Single Metal

Double Carbon

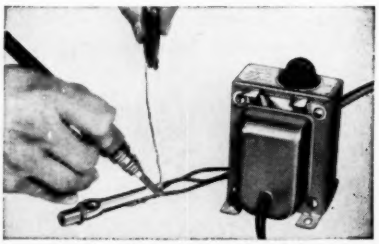
Single Carbon

for **miniature**
and **sub-miniature**
parts soldering

IDEAL

THERMO-TIP

RESISTANCE SOLDERING TOOL



Soldering large telephone jack with Thermo-Tip Resistance Soldering Tool and low voltage Ideal power unit.

Smaller, lightweight — for easy handling over prolonged periods of time. Thermo-Tip Tools are expressly designed as a production line tool. Reduces fatigue factor for women workers.

Pin-point accuracy. Pencil-small element fits into tight spots for foolproof soldering of small or miniature parts.

Fast, sure — Thermo-Tip elements concentrate high amperage current at soldering point for instant heat. Solder is melted by the parts to be joined—eliminates "cold flow joints", makes for positive union.

Versatile attachments—a variety of Thermo-Tip elements are available for every precision soldering purpose. Feed-thru electrodes on double metal, single metal and single carbon attachments provide longer life and easy length adjustment for specific job requirements.

Sold Through America's Leading Distributors. In Canada: Irving Smith, Ltd., Montreal

IDEAL **IDEAL INDUSTRIES, INC.**
1420-H Park Ave., Sycamore, Ill.

Gentlemen:

Kindly send us complete catalog information of Ideal's Thermo-Tip Resistance Soldering Tools.

Name.....

Company.....

Address.....

City.....Zone....State.....

For more information circle **104** on inquiry card.

TRANSDUCERS

for

ABSOLUTE, DIFFERENTIAL or GAGE PRESSURES

Outputs linear with pressure, pressure altitude and air speed.

For Recording, Control and Indicating in Industry.

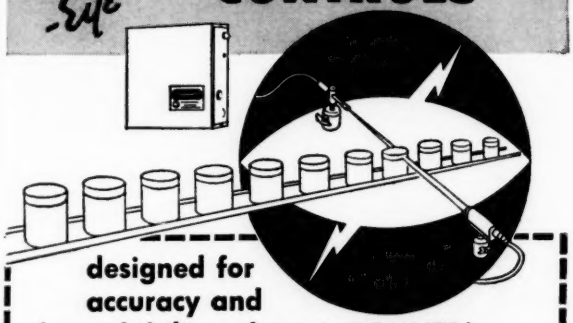
Write for complete technical information

COLVIN LABORATORIES, INC.
364 Glenwood Avenue, East Orange, N. J.
35 N. Arroyo Parkway, Pasadena 1, Calif.

Electro-mechanical instrumentation for aircraft, missiles, and industry

For more information circle **105** on inquiry card.

Robot-Eye **PHOTO ELECTRIC CONTROLS**



designed for accuracy and dependability where it *COUNTS!*

ROBOT-EYE Photo Electric Controls incorporate many of the newest and most advanced features of electronic design and component miniaturization, for greater efficiency and versatility of application.

THESE ROBOT-EYE FEATURES MEAN A HIGHER STANDARD OF OPERATION:

- Light and cell unit—swivel mounted for easy installation.
- Miniature construction permits installation in tight places.
- Cell unit with cadmium sulphide cell has greater life and sensitivity.
- Simple plug-in provision in amplifier for light and cell unit.
- Light source utilizes low voltage bulb, operating below rated voltage for increased bulb life.
- Unit will follow counting operations up to 600 per minute.
- Robot-Eye unit works from either direct beam; reflection from object or mirror reflection.

MODEL RE-3 $65.00
MODEL REC-36 with 6 digit reset counter $88.00

For complete information write to: Dept. IA-P-1-8

Robot-Eye **standard** INSTRUMENT CORPORATION
DIVISION OF HEAT-TIMER CORPORATION

657 BROADWAY, NEW YORK 12, N.Y.

STANDARD INSTRUMENT

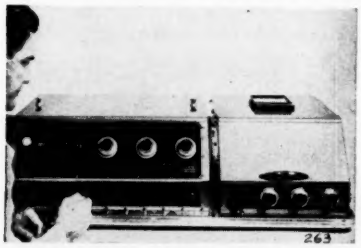
For more information circle **106** on inquiry card.

products, can measure in red, green, and blue regions.—*Magnusen Engineers, Inc., 509 Emory St., San Jose, Calif.*

For more information circle **495** on inquiry card.

COLOR-DIFFERENCE METER

New Model AC-2 Automatic Color Difference Meter makes possible extremely precise measurement of dark



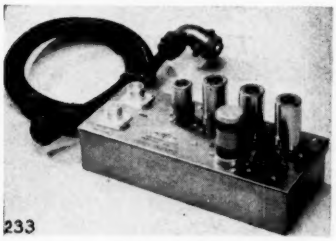
colors; features high-sensitivity head, automatic built-in standardization, new cabinet design, no exposed cables, null-balance system.—*Gardner Laboratory, Inc., Bethesda* 14, *Maryland.*

For more information circle **496** on inquiry card.

NUCLEONICS

AMPLIFIER FOR PROPORTIONAL COUNTING

New Model 255S amplifier for proportional counting is a non-overload-

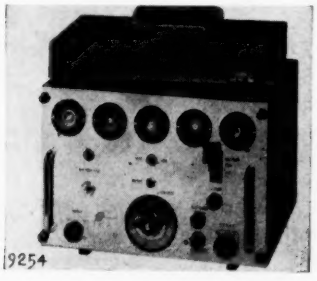


ing stable instrument for use with gas flow counters.—*Baird-Atomic, Inc., 33 University Road, Cambridge* 38, *Mass.*

For more information circle **497** on inquiry card.

BATTERY-OPERATED SCALER

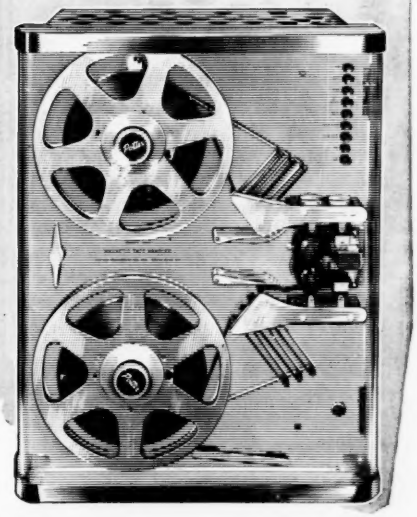
New "Model 2800," said to be unique, operates on its rechargeable battery or from an ac line; features a wide-band feedback amplifier, five glow-tube decades providing a scaling



Potter

Model 905 Digital Magnetic Tape Handler

(75 inches per second with 3 msec starts and stops)



Meets all requirements for speed and convenience in processing large quantities of digital data

The Potter Model 905 is the result of the most extensive study of data-processing requirements. It combines high speed with complete reliability and easy accessibility to all wiring and parts. The Potter machined bronze head with precisely aligned gaps provides dimensional stability and minimizes digital drop-outs caused by oxide pickup.

Tape widths:
A – ¼" (2 or 3 channels)
B – ½" (6 or 7 channels)
C – ⅝" (up to 8 channels)
D – ¾" (up to 10 channels)
E – 1" (up to 13 channels)
F – 1¼" (up to 15 channels)

Speed combinations:
J – 30 and 7.5 inches per second
K – 60 and 15 inches per second
L – 75 and 18.75 inches per second
X – Special (speeds up to 75 inches per second in ratios of 2 to 1, 3 to 1 and 6 to 1 are available on special order. Other speed combinations can be accommodated.)

Start time: 3 milliseconds
Stop time: 3 milliseconds
Reel sizes: 8" or 10½" standard NAB reels. Adaptors for other types can be provided.
Control: Front panel pushbuttons or remote control contact closure and pulses.
Weight: 100 pounds
Dimensions: Panel, width . . . 19"; height . . . 24½"
Depth behind panel . . . 13½"
Depth in front of panel . . . 3½"
Power Requirements: 110 to 120 volts, 60 cps, 400 watts.

For more information, write, wire or phone your Potter representative or the factory.

Potter **POTTER INSTRUMENT COMPANY, INC.**
115 Cutter Mill Road — Great Neck, L. I., N. Y.

Wescon Booth 1003; ISA Booth 1266

For more information circle **90** on inquiry card.

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating Instruments

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

Write For Catalog Information

PALMER
THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

For more information circle **108** on inquiry card.

NEW INSTRUMENTS

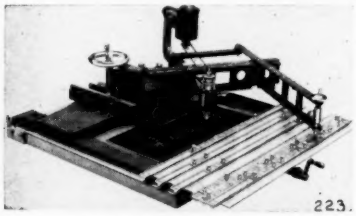
range of 100,000 with push-button reset, test position, spring-wound timer providing a predetermined time counting range from 0.25 to 6 min with a stop-count switch, regulated high voltage supply, and self-contained battery-charger regulator with automatic overcharging prevention.—*Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **498** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

ENGRAVING MACHINE

New Model I-R Engravograph is designed for engraving over-size panels which cannot be accomodated



by any other conventional engraving machines. Complete chassis can be removed from base and placed anywhere on a workpiece of any dimension.—*New Hermes Engraving Machine Corp., 13-19 University Place, New York 3, N. Y.*

For more information circle **499** on inquiry card.

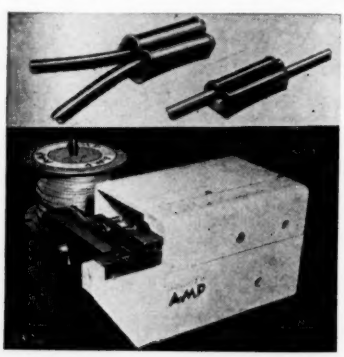
MAGNETIC CORES

New N400-080 magnetic cores for transistorized electronic computers are so tiny that a thimble will hold about 1000. In maintaining a ratio of 3 to 1 or better between a Read 1 and a Read 0, drive current used can vary plus or minus 7½% in 300 to 400 milliampere range, over a temperature range of 50 to 100°F.—*National Cash Register Co., Dayton 9, Ohio.*

For more information circle **500** on inquiry card.

SPLICE MACHINE

New "AMPli-var" splice and automatic splicing machine produce up to 1200 splices per hour with enamel

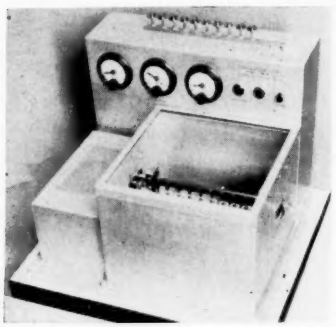


coated, polyvinyl acetal coated and similarly coated wire. Joint is hermetically sealed for resistance to corrosion.—*AMP Inc., Harrisburg 13, Pa.*

For more information circle **501** on inquiry card.

BEARING CLEANER

New automatic machine can clean 2400 precision bearings per hour; uses a narrow cone of high-velocity filtered



hot air to spray a controlled volume of a neutral and chemically pure solvent. At end of automatic cleaning cycle, reciprocating fixture holder withdraws to rear, and clean bearings are unloaded while dirty bearings are loaded. —*Cobehn, Inc., Caldwell, N. J.*

For more information circle **502** on inquiry card.

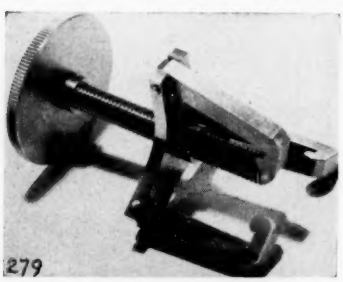
COIL BOBBINS

New small nylon coil bobbins are now available at low cost from stock in a variety of sizes in round, square, rectangular and oval shapes; sizes range from approximately ¼" dia by ¼" minimum length, up to ⅞".—*Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.*

For more information circle **503** on inquiry card.

PRECISION GEAR PULLER

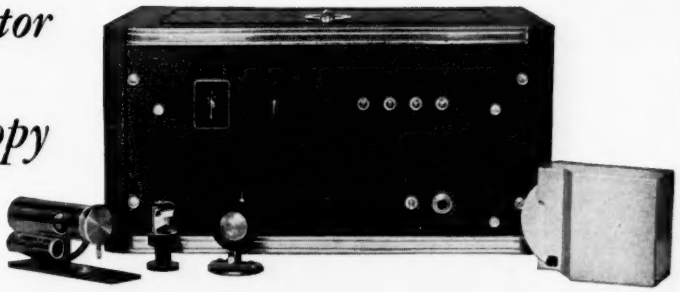
New fine-pitch precision gear puller handles gears from ½" to 3" diameters. Nylon ball on screw prevents



shaft being marred.—*PIC Design Corporation, 477 Atlantic Ave., East Rockaway, N. Y.*

For more information circle **504** on inquiry card.

A Superior Detector for Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.**
4. **Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.**

Write for EPLAB Bulletin No. 10

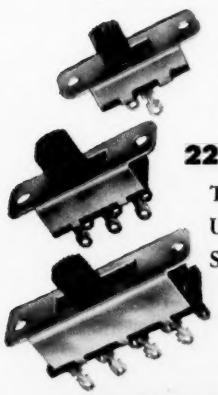
THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

For more information circle **109** on inquiry card.

LOW COST SWITCHES

FOR ALMOST ANY ELECTRICAL PRODUCT

Low-priced Stackpole slide switches provide practically any needed switching arrangement for appliances, instruments, radios, TV sets, small motors and electrical toys. They're sturdy, fully dependable, small in size.



22 STANDARD TYPES

Types from .5 to 3 amperes A.C. Underwriters approved. Write for Slide Switch Bulletin RC-9B to:

Electronic Components Division
STACKPOLE CARBON CO.
St. Marys, Pa.

STACKPOLE

Fixed and Variable Resistors • Iron Cores • Ceramag® ferromagnetic Cores • Molded Coil Forms • "GA" low-value Capacitors

For more information circle **110** on inquiry card.

"PRECISION-GAUGED" HAIRSPRINGS

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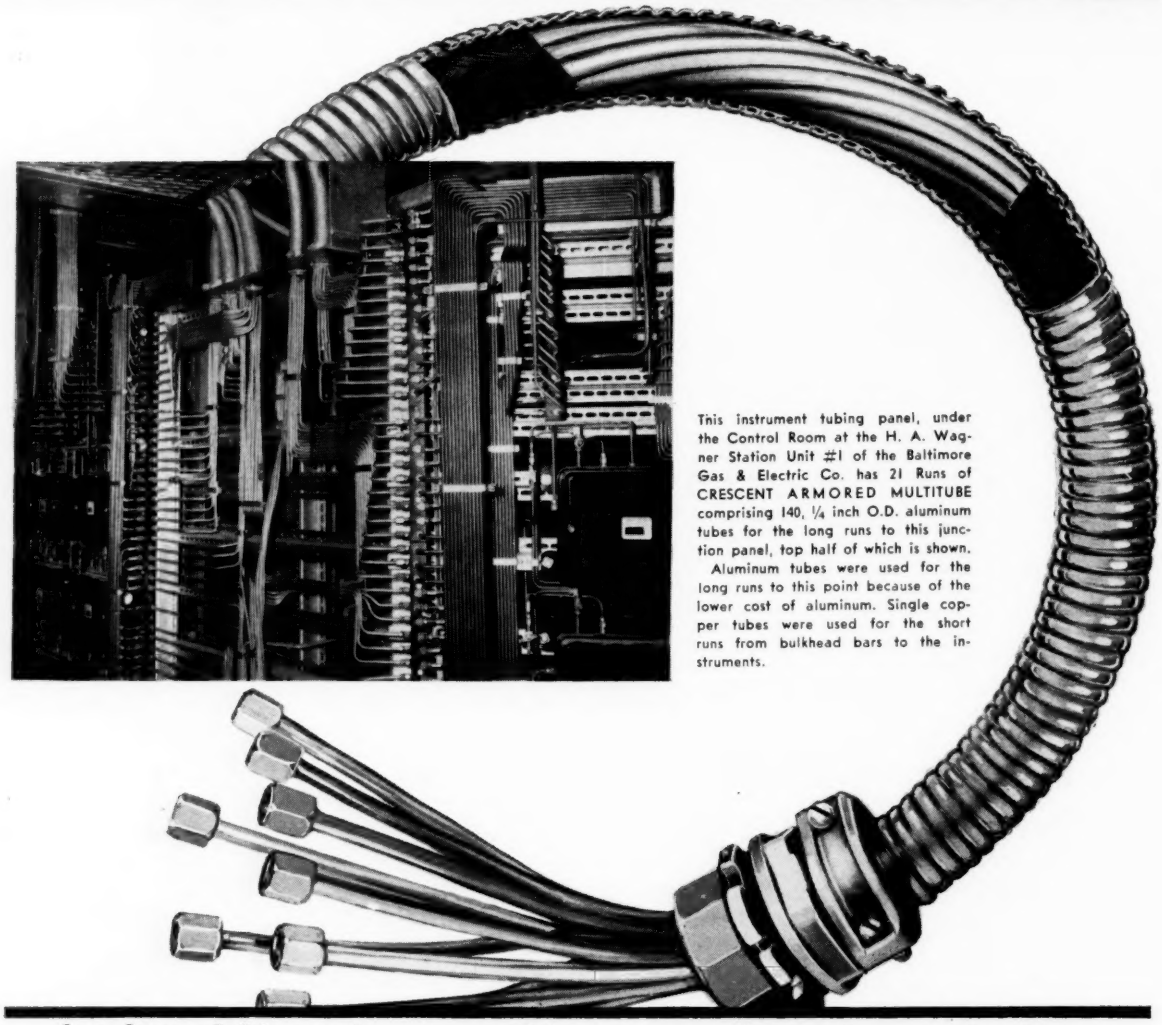
High volume production with absolute uniformity

PRECISION PRODUCTS COMPANY INC
OF WALTHAM
WALTHAM 54, MASSACHUSETTS

For more information circle **111** on inquiry card.

CRESCENT ARMORED MULTITUBE*



Tnis instrument tubing panel, under the Control Room at the H. A. Wagner Station Unit #1 of the Baltimore Gas & Electric Co. has 21 Runs of CRESCENT ARMORED MULTITUBE comprising 140, ¼ inch O.D. aluminum tubes for the long runs to this junction panel, top half of which is shown.

Aluminum tubes were used for the long runs to this point because of the lower cost of aluminum. Single copper tubes were used for the short runs from bulkhead bars to the instruments.

for dependable performance of instrumentation and control tubing

CRESCENT ARMORED MULTITUBE® is a group of tubes spirally cabled together. One tube in each layer is a bright blue color, which makes identification of any tube at both ends an easy matter.

Users report savings in installed cost of from two to five times the cost of CRESCENT ARMORED MULTITUBE as compared with the old method of using single tubes. Using the MULTITUBE system will result in fewer connections and fittings, lower cost for supports or racks, ease of mounting and less space.

The spiral cabling of the tubes prevents distortion when the entire assembly is bent on a short radius. The tubing assembly is protected by a flexible, interlocked galvanized steel armor, or by a tough corrosion-resistant thermoplastic sheath or both.

Furnished in from 2 to 37 Tubes of copper, aluminum, steel, polyethylene up to 1000 feet. Also special construction for underground runs. This product is licensed under U.S. Patent 2,578,280.

Send for Bulletin 356-A giving complete information and engineering data

CRESCENT INSULATED WIRE & CABLE CO.

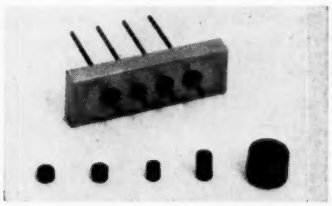
TRENTON, NEW JERSEY

* Reg. Trade Mark

For more information circle **112** on inquiry card.

SEALING CERAMIC

New "Ceramicite" for hermetric seal applications at high temperatures bonds physically to most stainless



steels. Its thermal expansion is similar to these metals'. Seals embodying "Ceramicite" are preformed pieces, ready for firing, and completed seal components.—*Consolidated Electrodynamics Corporation, 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **505** on inquiry card.

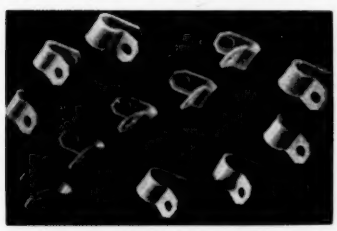
POLYESTER TAPES

New self-sticking tape, unlike cellophane, is dimensionally stable, high strength, non-brittle, is extremely thin and has a strong, clear adhesive. Tape is offered in 9 patterns, available in six standard widths from 1/32" to 1".—*American Chart Service, Inc., 101-103 Dover St., Somerville 44, Mass.*

For more information circle **506** on inquiry card.

TEFLON CABLE CLAMPS

New cable clamps fabricated from Teflon are tough and flexible, chemically inert, non-adhesive and heat re-



sistant over a wide temperature range.—*Weckesser Company, Dept. IAP, 5701 Northwest Highway, Chicago 30, Illinois.*

For more information circle **507** on inquiry card.

GLASS-TO-STEEL TERMINALS

New headers, based on maker's new formula V-24 glass, are made with solid glass interfusion between glass and electrodes plus controlled compression; resist vibration and mechanical and heat shock; minimize rejects due to in-plant handling. Four base designs. One to 21 electrode pins depending on size and type; six electrode pin styles; 88 types with 37 different pin layouts in three series.—*Fusite Corp., Dept. PB, 6000 Fernview Ave., Cincinnati 13, Ohio.*

For more information circle **508** on inquiry card.

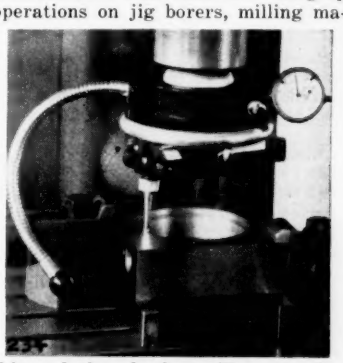
SELF-ADHESIVE LABELS

New "Write-On" labels have adhesive that sticks and stays stuck to any clean dry surface; come off clean when purposely removed.—*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.*

For more information circle **509** on inquiry card.

CENTER LOCATING TOOL

New Centricator is for trueing bores and external diameters in setting-up operations on jig borers, milling ma-



chines, lathes, boring mills, etc.—*Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.*

For more information circle **510** on inquiry card.

pH READINGS
ANYWHERE—INSTANTLY
WITH THE ANALYTICAL POCKET pH METER

Completely self-contained in water-proof, ever-ready case.

Instrument size: 3 x 5⅞ x 2½ inches
Case size: 3¾ x 6½ x 4⅛ inches
Weight with accessories: 3 lbs.

$125.00

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585 Main Street, Chatham, N.J.

Please send full information about your pocket pH meter to:

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For more information circle **113** on inquiry card.

NEW!

DAVIS
PARTS-PER-MILLION
OXYGEN ANALYZER

For Continuous Monitoring of Oxygen Content

Continuously monitors oxygen content of process plant gas streams in parts-per-million. Full range sensitivities of 0 - 50 to 0 - 2,000 p.p.m.

Applications include: trace oxygen control in polymerization of butadiene, ethylene, etc.; determination of oxygen in nitrogen, helium, argon and other inert or noble gases; detection of oxygen impurity in hydrogenation processes; and monitoring of oxygen content to prevent catalyst poisoning.

Write for Bulletin #11-40

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DAVIS INSTRUMENTS

A Division of Davis Emergency Equipment Co., Inc.

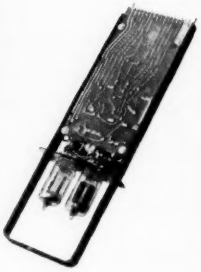
80 Halleck St., Newark 4, N. J.

For more information circle **114** on inquiry card.

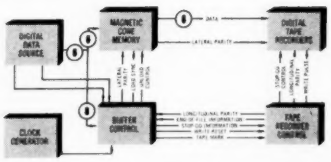
End data format problems

with the NEW EECO

FORMAT CONTROL BUFFER



... Converts input data into compatible format for your individual Data Processing Equipment.



The basic EECO Format Control Buffer accepts digitized data at random rates and produces digital magnetic tapes in the computer Format, suitable for entry into virtually any computer depending on the Format Control Buffer Model. *It can also be furnished to provide for conversion from one computer format to another.* And it can be modified to handle conversion to paper tape, punched cards, or digital plotters.

Input Input can be from such sources as: **Analog-to-digital Converters • Time Registers • Punched Card Readers • Electric Typewriters • Punched Paper Tape • Digital Magnetic Tape**

Source material is presented to the Format Control Buffer as parallel input. Control inputs are normally provided by the data source. And EECO can incorporate a digital multiplexer in the Format Control Buffer to meet your individual requirements for entering data from multiple sources.

Data Input Rate The EECO Format Control Buffer can be set to produce records of any desired length from one to 1024 characters.

Each complete record is read out of the magnetic core memory onto the output magnetic tape at the specified recording density

Maximum **instantaneous** input rate approximately 40,000 characters per second.

Maximum **average** input rate is limited by average output rate, which, in turn, is determined by the digital recorder tape speed and by the number of characters per record.

Output Format Meets all requirements of the computer format, including parity, check, inter-record and end-of-file gaps, and end-of-file characters or gap.

Construction EECO Computer-Series plug-ins are used extensively These incorporate specially designed, ultra-conservative circuits to ensure greatest possible reliability.

Full details on the new EECO Format Control Buffer are contained in Bulletin FC-234. Send for your copy today and learn how you can increase the scope of your Data Processing Equipment.

ELECTRONIC ENGINEERS AND PHYSICISTS

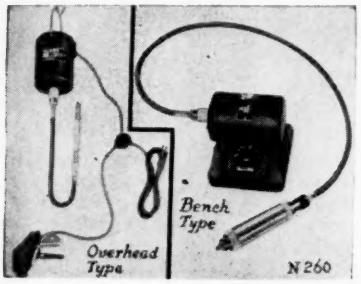
EECO offers unusual career opportunities in the creative field of systems and related electronic projects. Send resume of your qualifications to the attention of R. F. Lander.

Electronic Engineering Company
of California
1601 East Chestnut Avenue • Santa Ana, California

For more information circle **115** on inquiry card.

FLEXIBLE SHAFT MACHINES

New "Overhead and Bench-Type Flexible Shaft Units," designed for



grinding, piercing, routing, hammering, riveting, etc., feature adjustable speeds up to 10,000 rpm; pre-lubricated ball bearings, etc.—*L & R Mfg. Co., 577 Elm Street, Arlington, N. J.*

For more information circle **511** on inquiry card.

PRINTED CIRCUIT MODULE

New plug-in "Ansley Plus Module," using standard printed circuit materials and techniques and standard components, is said to "add a third dimension to printed circuitry." It features compactness, rugged construction, flexibility of design and accessibility of components for service.—*Arthur Ansley Mfg. Co., New Hope, Penna.*

For more information circle **512** on inquiry card.

PRINTED CIRCUIT PANEL

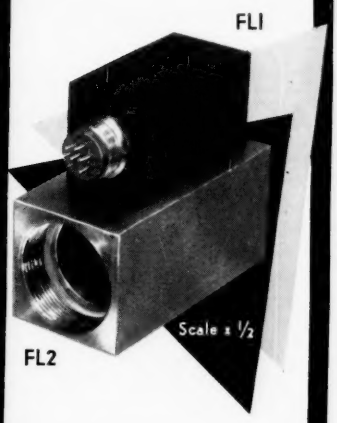
New type of printed circuit panel —first to be molded of resins—obviates use of expensive piercing dies

and punch presses; sells for two-thirds the cost of an average etched panel; provides indestructible attachment of components by automatic soldering without use of adhesives or cleaning after assembly.—*Die Form Circuits, Inc., 6045 W. Ogden Ave., Cicero, Ill.*

For more information circle **513** on inquiry card.

Dynisco

HI-FI FLOWMETER



Incorporates Unbonded Strain Gage

HIGHLIGHTS

ACCURACY WITH STEADY OR PULSATING FLOW

FOR USE WITH CORROSIVE MEDIA

LINE PRESSURES to 2000 psi

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0.005-0.12 cu. ft. gas/sec.
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For more information on Dynisco pressure, displacement, flow, and force pickups—Write:

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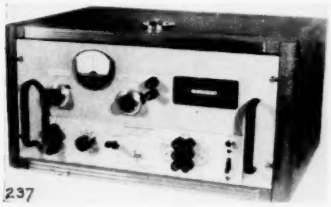
CAMBRIDGE 42, MASS.
UN-47260

For more information circle **116** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

TEST-LIMITS CONTROLLER

New Programmer Counter is used to turn on and off test apparatus whose limits are sensed by strain



gages or other pickups with maximum output not exceeding 100 mvdc; obviates need for manual control of test cycling.—*Spar Engineering & Development, Inc., Wyncote, Pa.*

For more information circle **514** on inquiry card.

RANGE FINDER

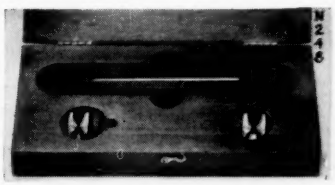
New six-inch-base telemetric instrument for easily and quickly measuring distances from 8 to 100 ft is of

image-coincidence type: one image is seen in its natural color and the other image in "gold." Knob is turned until images coincide; dial then indicates distance to object sighted.—*Edmund Scientific Co., Barrington 25, N. J.*

For more information circle **515** on inquiry card.

MICRO SCALES

New "EMscales" available in lengths up to 12" and sub-divided into increments of 0.001", are accurate to



0.0001"; can be made of many materials, e.g. the material being measured—whence no need for temperature control of working area. They can be fixed to a moving part, and microscope to a stationary one, or vice versa.—*Elliott-Myers Corp., 109 Hammond Rd., Warren, Pa.*

For more information circle **516** on inquiry card.

CRITICAL POT SPECS* are met at CIC

Equipment designers who demand more than "shelf item" specifications, rely on CIC for dependable delivery of ultra-precise potentiometers.

The result of CIC research, carbon film potentiometers are setting new standards of accuracy, life at higher speeds and performance reliability.

CIC has assisted many firms in a wide variety of industrial instrumentation, military fire control and flight guidance equipment.

Why not discuss your specific requirements with us?

*New carbon film techniques assure virtually infinite resolution; linearity to .01%, sine-cosine to .025%; compact ganging; precision ball bearing servo construction.

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Detailed Technical Data Sheets available on request.

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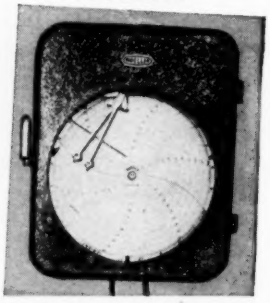
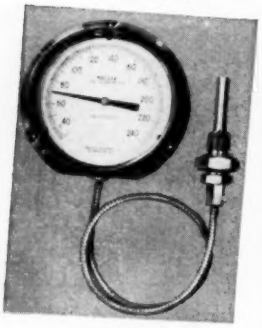
For more information circle **117** on inquiry card.

You get *dependability* PLUS with Moeller dials and recorders

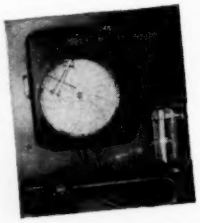
Adjustable Form Dial Indicating Thermometers with separable socket. Can be quickly adjusted to any angle.



Single and Multiple Pen, Remote Recording Thermometers. Available for one and two temperature recordings in round cases and up to four temperature recordings in rectangular cases.



Remote Reading Dial Thermometers. Mercury actuated, with separable socket. Panel or flush mounting.



Moeller Recording Psychrometer Type No. 6630 (wet and dry bulb temperature type) for accurate humidity determinations and records. Designed for rooms or apparatus where air circulation is poor.

...because our business is the design and manufacture of temperature measuring instruments—and has been since 1867.

Specify and install these guaranteed Moeller Products. *Mail the coupon, today, for full details!*

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132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Dials and Recorders.

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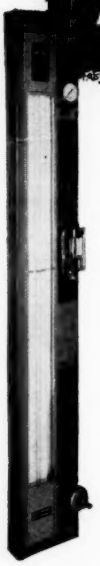
For more information circle **118** on inquiry card.

Petrometer
SERIES 1400
LIQUID DEPTH GAUGES



ACCURATE and EASY TO INSTALL

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

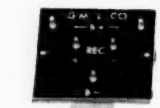
For complete information send for Bulletin 6004

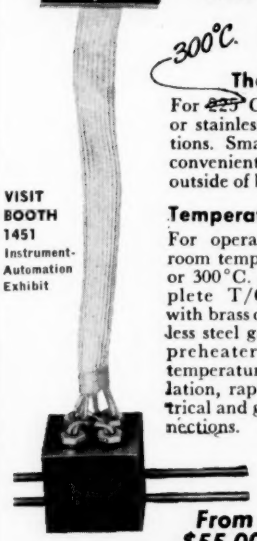
Petrometer CORPORATION
43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **119** on inquiry card.

Fast! Accurate! Economical!

GOW-MAC GAS CHROMATOGRAPHY CELLS





VISIT BOOTH 1451 Instrument-Automation Exhibit

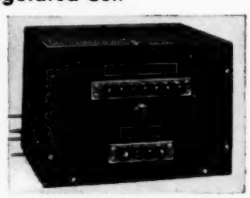
300°C.

Thermal Conductivity Cell

For ~~225~~ C operation. Three models in brass or stainless steel to meet specialized applications. Small internal volume, fast response, convenient mounting, electrical connection outside of bath.

Temperature Regulated Cell

For operation at room temperature or 300°C. A complete T/C unit with brass or stainless steel gas flow, preheater, close temperature regulation, rapid electrical and gas connections.



Power Supply and Control Unit

gives five minute hook-up with complete circuitry for these T/C cells. For catalogs or recommendations, write Dept. IA

From $55.00

GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.
Telephone FR [illegible] 7-3450

For more information circle **120** on inquiry card.

MECHANICAL TESTING

ACCELERATOR AIR SYSTEMS

Two new air system installations are now available as accessories for maker's Model E185 G-Accelerator, for supplying air and other non-corrosive fluids under vacuum and pressure conditions to test objects being subjected to simulated operational G-loadings.—*Genisco Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

For more information circle **517** on inquiry card.

ENVIRONMENT CHAMBERS

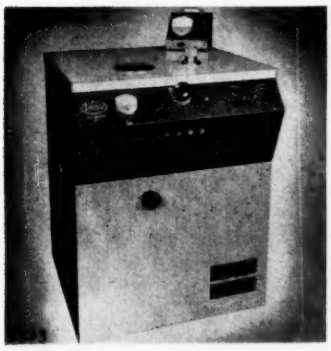
New modifications to "WEATHERLABS" include feed-through terminal blocks (all sizes) for testing electrical

devices under various temperature and humidity conditions when connected to external instrumentation; removable center mullion so that large units can be tested.—*Labline, Inc., Hudson Bay Co., Div., 3070 W. Grand Ave., Chicago 22, Ill.*

For more information circle **518** on inquiry card.

LEAK TESTER

New Model MS 9-AB leak testing system, complete in mobile console and based on a new mass spectrometer

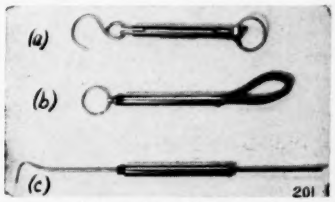


leak detector, is capable of 100 or more tests per hour; can be extended to provide back-filling and other facilities, including full go no-go automatic operation. Sensitivity one part in 10 million.—*Vacuum Electronic Engineering Co., 86 Denton Ave., New Hyde Park, N. Y.*

For more information circle **519** on inquiry card.

TENSION TESTERS

Three new tension testers: (*a*) tester with pointer; (*b*) tester for testing tension of electric motor

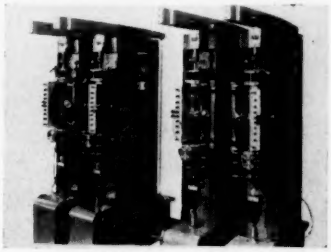


brushes; (*c*) push-pull tester for testing compression or tension in control mechanisms.—*All-Weather Springs, 56 Main St., Millburn, N. J.*

For more information circle **520** on inquiry card.

TESTING MACHINE FOR OPTICAL CREEP MEASUREMENTS

New testing equipment for use with vaccum furnaces arranged for optical creep measurements was designed for



use on molybdenum or any materials that are active chemically with the atmosphere at elevated temperatures. —*Richle Testing Machines, East Moline, Illinois.*

For more information circle **521** on inquiry card.

HIGH-TEMPERATURE OVENS

New high performance ovens were tested with thermocouples placed 2" and 6" from work chamber walls as

prescribed by ASTM. At 752°F, a thermocouple placed in middle of work chamber showed a maximum fluctuation of only 0.3 F° under equilibrium conditions. Still greater stability at lower operating temperatures.—*American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.*

For more information circle **522** on inquiry card.

Stromberg-Carlson's new type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the sketch above shows, our new frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeably with brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the new "E" relay are—

★ **Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

★ **Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

★ **Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
TELECOMMUNICATION INDUSTRIAL SALES
113 CARLSON ROAD, ROCHESTER 3, N. Y.

For more information circle **121** on inquiry card.

HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

The Therm-O-Disc Type E Series Thermostat is designed for compact installations in clothes dryers, room and unit heaters, central heating furnaces, air conditioning and ventilating equipment, aircraft and miscellaneous devices, for controlling temperatures up to 350°. Both the EA and EC Series are for single pole, single throw operations and can be supplied with normally closed or normally open contacts. The EA (shown) is best suited for controlling temperatures in air streams; the EC is intended for surface mounting. Both types are actuated by an exposed disc of Chace Thermostatic Bimetal, altho EA is also available with enclosed disc for protection against dust, lint, moisture, etc.

Here's how Therm-O-Disc works; The pre-calibrated disc of Chace Thermostatic Bimetal snaps from a normally concave to convex form at the pre-set point of temperature rise, in the manner of an "oil can". The impact of this positive snap action against a bumper causes instantaneous make or break of the contacts or circuit. Upon cooling, the disc snaps into the original concave form, resetting the contacts.

Remember Chace when you design for temperature actuation or indication, or for protection of valuable equipment. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal", containing interesting uses of bimetal and many pages of engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **122** on inquiry card.

NEW INSTRUMENTS

ELECTRICAL TESTING

STEP INPUT UNIT

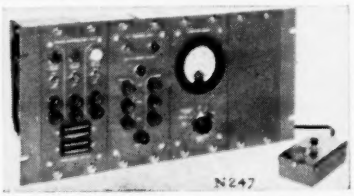
New Model 51 step input unit makes possible data plotting of any number of preset increments up to 999 steps

along one axis; is for use with maker's Autograf X-Y Recorder; provides means for producing bar-type graph to any scale on standard or non-standard graph paper.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*

For more information circle **523** on inquiry card.

TEST RACK EQUIPMENT

New equipment, said to "revolutionize presently-used lab testing techniques," provides (1) standard-



ized distribution of all power on bench; (2) fingertip centralized prime power control; (3) remote and local control of three HV power supplies; (4) high voltage bias interlock protection; and (5) fingertip monitoring of prime power voltages, + and − B currents, and + and −B voltages. —*Electro-Mechanical Devices Corp., 453 Front St., Covina, Calif.*

For more information circle **524** on inquiry card.

GROUND DETECTOR

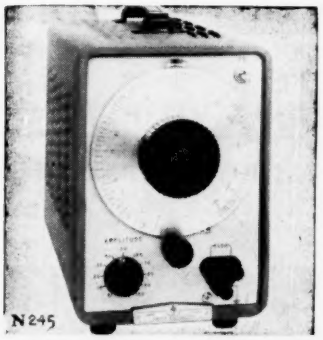
New high-voltage Allen Ground Detector tests ungrounded and modified grounded circuits from 0 to 2300 volts

while circuits are "hot" and equipment is operating.—*Excel Electric Service Co., 2113 South Western Ave., Chicago 8, Ill.*

For more information circle **525** on inquiry card.

SWEEP OSCILLATOR

New "DY-2200" covers 5 to 5,000 cps frequency range in one continuous band: no switching transients and



dial discontinuities; no need of zero setting. To provide for attachment of mechanical sweeping components, etc., tuning shaft extends at rear. Standard rack-panel mounting or portable cabinet.—*Dynac, Inc.*, 395 *Page Mill Road, Palo Alto, Calif.*

For more information circle **526** on inquiry card.

TV AND RADIO TESTER

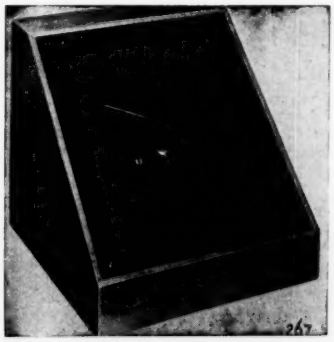
New Model 850 Induced Waveform Analyzer is a new instrument which adapts service or lab 'scope for

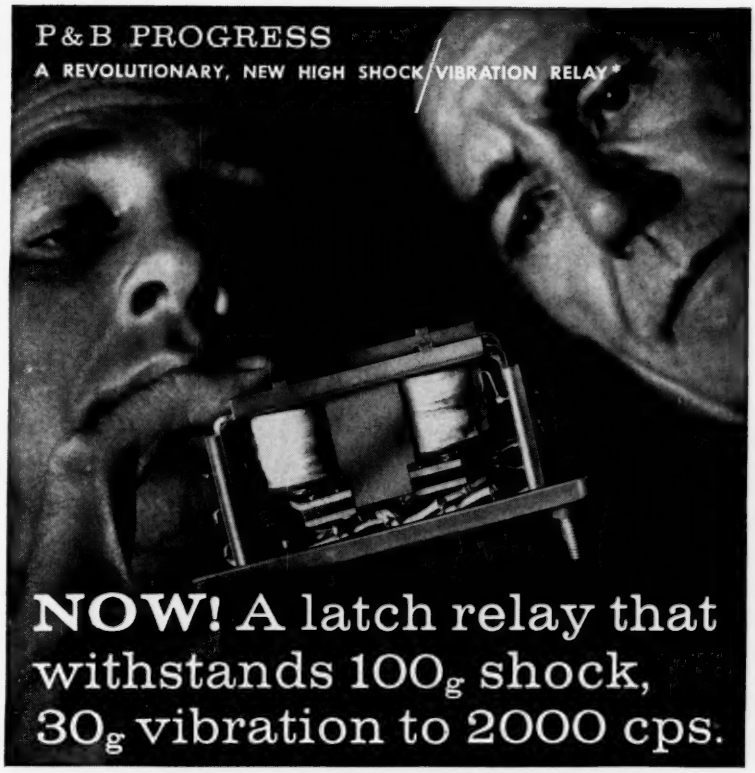
troubleshooting TV and radio receivers above chassis without connection to circuit. "Phantom Probe" pickup loops are placed over tubes to pick up signal by capacitance coupling, thus making every tube a test point.—*Winston Electronics, Inc.*, 4312 *Main St., Philadelphia* 27, *Pennsylvania.*

For more information circle **527** on inquiry card.

TRANSMITTER BRIDGE

New Model E-2582 Synchro Transmitter Bridge for electrical error tests of synchro transmitters and receivers




P&B PROGRESS
A REVOLUTIONARY, NEW HIGH SHOCK/VIBRATION RELAY*
NOW! A latch relay that withstands 100g shock, 30g vibration to 2000 cps.

ONLY 2.0 WATTS AT NOMINAL VOLTAGE FOR 12 MILLISECONDS EFFECTS ARMATURE TRANSFER

The secret of the KG's dramatically high resistance to shock and vibration is a permanent magnet which locks the armature into position.

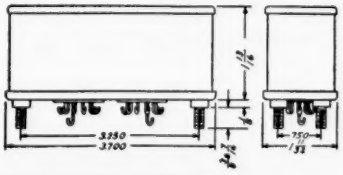
Tests show the contacts will open for no more than 80 microseconds during 100g shock.

Armature transfer from one set of the 6PDT contacts to another can be made in approximately 12 milliseconds with only 2.0 watts at nominal voltage.

Write or wire today for complete technical data.

*KG Relay Patent Pending

STAR SERIES KG RELAY ENGINEERING RESUMÉ



DESIGNATION: KG23DBH

GENERAL: Insulating Materials: Teflon, glass and ceramic.
Insulation Resistance: 100 megohms min.
Breakdown Voltage: 500 V. RMS.
Shock: 100g where contact openings less than 80 microseconds may be permitted.
Vibration: 30g 5 to 2000 cycles.
Ambient Temperature: —65°C to +125°C.
Weight: 13 ozs.
Pull-in-Speed: 12 MS using 310 ohm coil at 24 V. DC. (25°C).
Terminals: Two 11 pin multiple solder headers with hook ends for 3.20/AWG wires.
Enclosures: Hermetically sealed only.
Dimensions: 1-11/32 x 3.700 x .1-13/16 (See drawing for width, etc.)

CONTACTS: Arrangements: 6 pole double throw.
Load: Dry circuit to 3 amps, 115 V. AC, resistive. 5 amps, 28 V. DC, resistive.

COIL: Power: 2.0 watts at Nominal Voltage.
Duty: Either coil may be left energized without damage to the relay.
Insulation: Teflon tape.

MOUNTINGS: Four ⅜ inch #8-32 studs on 3¼ x ¾ inch centers.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

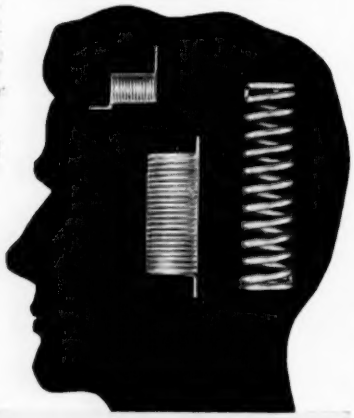
See What's New in P&B Progress at Booths 603, 604 WESCON, San Francisco, August 20-23

Potter & Brumfield, inc.

PRINCETON, INDIANA Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

For more information circle **123** on inquiry card.

SPRINGS ON YOUR MIND?



• Your next thought should be of the Spring Engineers at John Chatillon & Sons. Send them your blueprints and specifications for study and recommendation.

• With more than 120 years of experience and knowledge at their command, they can provide you with the exact spring you require—on time, at competitive prices.

• Chatillon has the trust of the largest users of springs in the world because of the Chatillon reputation for filling orders that others would consider impossible.

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85 CLIFF STREET, NEW YORK, N. Y.

Manufacturers of Precision Springs and Force Measuring Instruments Since 1835.

For more information circle **124** on inquiry card.

has rated input of 115 v 400 cps; one 72-position switch gives readings in 5° increments from 0 to 360°. Total resistance of each of the three voltage-divider arms 10,000 ohms and equal within 0.005%. Resistors in each of voltage-divider arm linear to within 0.005%, phase shift no more than 5 minutes.—*Gray Instrument Co., 200 E. Church Lane, Philadelphia, Pennsylvania.*

For more information circle **528** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

DC VOLTMETERS

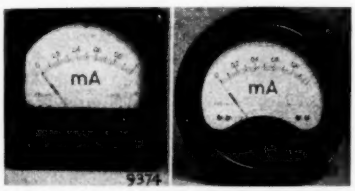
New DC Switch Module combines with Universal Power Module to

make a digital voltmeter with 0.01% accuracy.—*Electro Instruments Inc., 3794 Rosecrans, San Diego, Calif.*

For more information circle **529** on inquiry card.

DC INSTRUMENTS

New line of 0.5% accuracy permanent-magnet moving-coil ammeters, milliammeters, microammeters, volt-

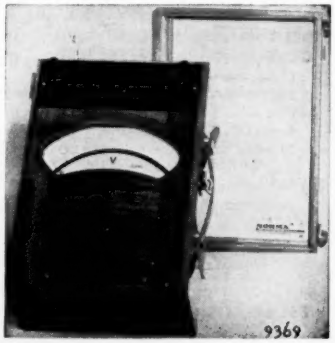


meters and millivoltmeters (made in Switzerland to PRL specs) is available in US.—*Physics Research Labs, Inc., P. O. Box 555, Hempstead, N. Y.*

For more information circle **530** on inquiry card.

AC-DC VOLTMETER

Newly Swedish-made precision-voltmeter Model 1 Ve features iron-shielded electrodynamometer move-



ment of dc and ac; 3 ranges with full deflections for 75, 150 and 300 v; accuracy 0.2%.—*Oltronix Co., 235 Underwood Dr. N. W., Atlanta 5, Ga.*

For more information circle **531** on inquiry card.

DC MICROVOLT-AMMETER

New Model 203AR, 19" rack-mountable combination dc microvoltmeter, microammeter, and low-level dc ampli-

fier, can measure as little as 10 microvolts or 100 micro-micro-amperes.—*KIN TEL (formerly Kay Lab), 5725 Kearny Villa Road, San Diego 11, Calif.*

For more information circle **532** on inquiry card.

VOLTAGE RATIO METER

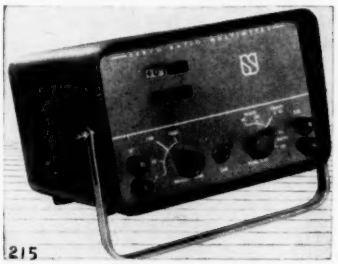
New Model E-2554 Precision Voltage Divider measures ac or dc voltage ratios between 1.00000 and 0.00001 in

steps of 0.00001 with accuracy of 0.001% of total resistance; maximum input 250 v rms ac or dc.—*Gray Instrument Co., 200 East Church Lane, Philadelphia, 44, Pa.*

For more information circle **533** on inquiry card.

VOLTAGE RATIO METER

New Servo-Ratio Multimeter computer test instrument measures ac-dc ratios, absolute ac-dc voltages, and re-



sistance, computes voltage ratios by dividing voltage to be measured by reference voltage obtained from the computer.—*Union Switch & Signal, Div. of Westinghouse Air Brake Company, Swissvale, Pa.*

For more information circle **534** on inquiry card.

ADJ OPTICS

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368 — 3369

A LIST OF MATERIALS WE FABRICATE USED IN OPTICS AND ELECTRONICS

SAWING GRINDING POLISHING DRILLING

ALUM
ALUMINA
ALUMINUM
ANTHRACENE
ARSENIC TRISULPHIDE
BARIUM TITINATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COPPER
*CORNING 707
*CORNING 7052
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITINATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **125** on inquiry card.

WEKSLER INSTRUMENTS

MIDGET SENTINELS!

For TIGHT *Corners*

Weksler Midget Industrial Thermometers are highly accurate instruments – small and adaptable – ideally suited for installation in pipe lines, tanks, stills, vulcanizers, pasteurizers, etc.; in solutions of oil, gasoline, water, etc.

ILLUSTRATIONS ONE-HALF ACTUAL SIZE

Heavy chrome-plated brass case with a 4½" scale opening. Easy reading yellow back tube – mercury column in lens front. Etched glass tube for greater accuracy – replaceable without removing well. 18-8, type 304 stainless steel wells, 1/4" N.P.T. in standard stem lengths.

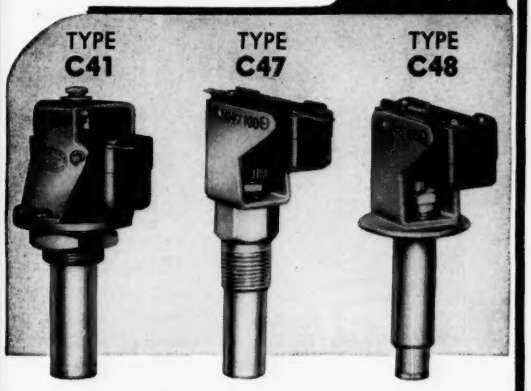
FOR COMPLETE INFORMATION, WRITE:

WEKSLER THERMOMETER CORP.
195 E. MERRICK ROAD, FREEPORT, L. I., N. Y.

For more information circle **126** on inquiry card.

SPACE OR WEIGHT LIMITATIONS?

C41 | C47 | C48



Specify Local Mounted **UE** *Skeleton Type* TEMPERATURE CONTROLS

UNITED ELECTRIC temperature controls are precision-built, compact and economical. Type C41 can be used for the control of either air or liquid temperatures . . . Type C47 for liquid temperatures . . . and Type C48 for air temperatures. These controls are direct-immersion units designed for easy installation.

Temperature Ranges	100° or 200° between 0° and 425° F limits
Thermal Assemblies	various immersion lengths . . . liquid-filled seamless brass bellows operate by hydraulic action
Switch Ratings	15 amps or 20 amps at 115 or 230 volts A.C., also D.C. switches available upon specification
Switch Types	N.O., N.C., or Double Throw, no neutral position
Electrical Connection	attached directly to screw or solder terminals on switch
Size & Weight	approx. weight . . . 4½ oz., approx. size . . . 3⅞" x 2" x 1¼"
Variations	design variations available upon specification

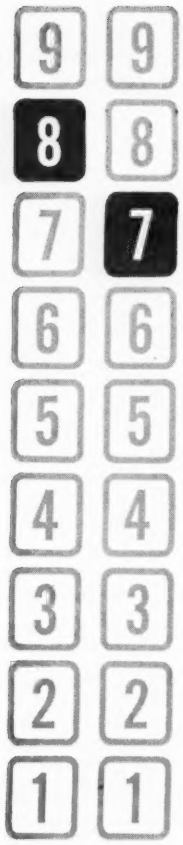
UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. Modified or custom-built units are a UE specialty. Consult a UE application engineer for a speedy solution to your problem.*

Write for Bulletin No. 2-2 today.

U.E.

United Electric Controls
COMPANY
82 SCHOOL STREET WATERTOWN, MASS

For more information circle **127** on inquiry card.

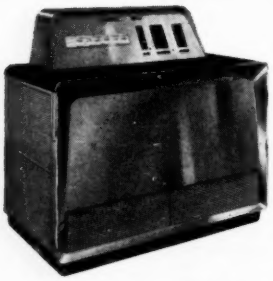


Take a number from one to one hundred!

BJ Electronics' new S-100 DIGITAL DATA PROCESSING SYSTEM samples 1 to 100 Transducers at rates up to 100 per second.

Precise, instant measurement of the variables of pressure, temperature and other inputs are provided to S-100 by as many as 100 miniature Vibroton Digital Transducers. Analog-to-digital conversion inaccuracies are eliminated by these vibrating-wire sensing devices. Measurement is signaled in terms of frequency, delivering direct-digital information sequentially or *on demand* to S-100 at sampling rates up to 100 per second.

This information is processed against programmed storage register data and routed through format control to system outputs for tabulations, visual readout, punched cards, tape or other output media. Output provisions for process monitoring and control may also be incorporated.



S-100 System

See S-100 in action!
ISA SHOW
Cleveland, Ohio
September 9-17, 1957
Booth No. 118

Vibroton® Digital Transducer

Write for Technical Bulletin 58-112

Qualified engineers are assured interesting, rewarding careers at this new Borg-Warner electronic facility. Inquire today of O. C. Bowers, Chief Engineer.

BJ ELECTRONICS

Reliability you can count upon

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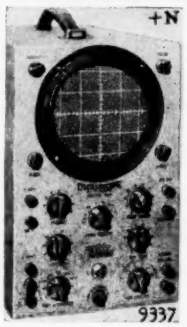
3300 NEWPORT BLVD. • P. O. BOX 1679 • SANTA ANA, CALIF.

For more information circle **128** on inquiry card.

NEW INSTRUMENTS

WIDE-BAND OSCILLOSCOPE

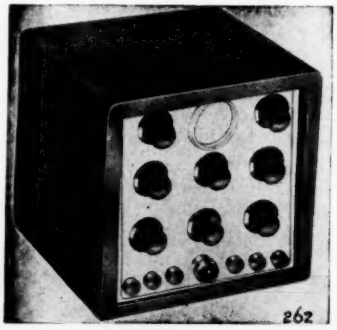


New ac-dc Model 460 lab and TV 5-Mc bandwith 'scope kit features d-c amplifiers said to give, zero tilt on low-frequency square waves. Also can reproduce 3.58-Mc sync burst and 3.58-Mc oscillator signals in color TV receivers.—*Electronic Instrument Co.*, 84 *Withers St.*, *Brooklyn* 11, *N. Y.*

For more information circle **535** on inquiry card.

PORTABLE OSCILLOSCOPES

New Series 300 Mini-Scopes comprise three models with frequency response from dc to 150 kc, 3 db down,

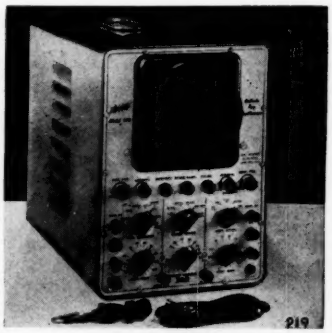


usable to 200 kc. Dimensions are about 5" cube; weight less than 4 lbs.—*Special Products Corp.*, 675 *Barbey Street*, *Brooklyn* 7, *New York.*

For more information circle **536** on inquiry card.

PORTABLE OSCILLOSCOPE

New Model 685 with ac and dc amplifiers, dc to 750 kc response and 20 millivolt rms per inch sensitivity,



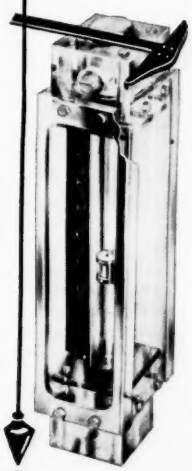
has shock-mounted amplifiers and associated circuit design to give excellent stability.—*Hickok Electrical Instrument Co.*, 10519 *Dupont Ave.* *Cleveland* 8, *Ohio.*

For more information circle **537** on inquiry card.

BROOKS LEADERSHIP
achieved by design

FULL-VIEW* ROTAMETER

NO TORQUE
NO LINE STRAIN



dowel pins make the difference

8 stainless steel dowel-pins precisely align the side plates and end fittings, are the keys to quick, trouble-free assembly and maintenance of the Brooks Full-View* Rotameter. The metering tube is installed *after* the frame is completely assembled. Tube breakage due to line strain and misalignment is thereby eliminated. It's as simple as placing a round peg in a round hole.

This feature, if considered alone, would make dowel-pin, side-plate construction your most important rotameter specification.

Send for Bulletin 115

*Trade-Name

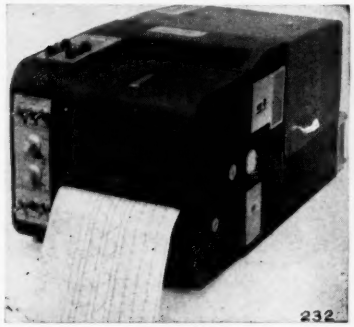
BROOKS ROTAMETER COMPANY
Lansdale, Pennsylvania

A complete line...
BROOKS ROTAMETERS
...for every service

For more information circle **129** on inquiry card.

OSCILLOGRAPH

New Recording Oscillograph gives direct readout at exceptional speeds; offers up to 50 channels of informa-



tion; writes at speeds above 30,000 ips.—*Midwestern Instruments, Tulsa, Oklahoma.*

For more information circle **538** on inquiry card.

OSCILLOGRAPH

New Type 5-122 oscillograph specifically developed for flight-test recording at high temperatures is ex-

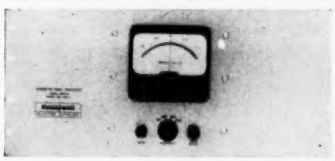
plosion-proof; operates at altitudes up to 120,000 feet.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **539** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

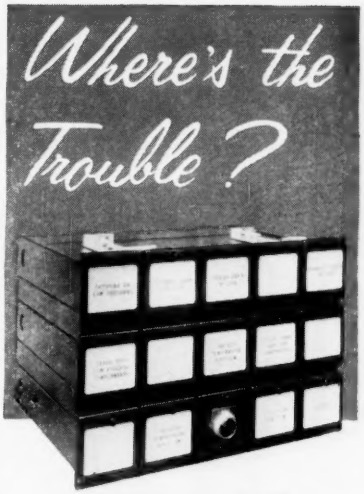
NULL INDICATOR

New Model 2GH-IR Magnetik Null Indicator for dc bridge measurement, designed for mounting on any stand-



ard 19" relay rack, can be used as a null balance detector or for linear deflection measurements.—*Minneapolis-Honeywell, Boston Div., 1400 Soldiers Field Road, Boston 35, Mass.*

For more information circle **540** on inquiry card.



SCAM
SEQUENTIAL ANNUNCIATORS
Will Tell You!

Scam sequential annunciator systems provide an audible and flashing visual signal on the first alarm to enable the operator of your control board to determine which point in the monitored process first becomes abnormal . . . successive alarms that develop from the original abnormal condition are indicated by a steady visual signal. You can take proper corrective measures immediately because you *know* where the trouble started.

Shown here is a typical standardized Scam E-LINE cabinet with integral flasher and reset pushbutton, featuring all the Scam advantages including simple, compact plug-in design.

If you've a process or system that needs automatic, fail-safe, low cost monitoring write us for literature or call the nearest representative in the cities listed below.

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and Vancouver, Canada

For more information circle **130** on inquiry card.

ONE INTEGRAL UNIT for Absolute, Simplified Control of Vacuum, Pressure and Flow

HOKE MANOSTAT MODEL #10

This highly accurate, sensitive instrument is based on the same principle of operation as the cartesian diver type toy you played with as a child. Remember how the slightest pressure on the bottle sent the diver to the bottom? This clever use of an inverted, trapped-gas float immersed in liquid has been applied to industrial vacuum, pressure and flow control by Hoke-Manostat with the introduction of Model #10 . . . a completely self-contained instrument featuring a balanced orifice that provides flow rates up to 200 CFH with sensitivity equal to 0.1% or 0.1 mm, whichever is greater. It will control vacuum down to 1 mm Hg absolute, or pressure up to 500 psig. What's more, it is an instrument with a "memory" — remembering established settings after process shutdown.

Just 13 inches long and 3¼ inches wide, Model #10 does the work of transducer elements, control circuits and external power units. It needs no wiring or copper tubing for signal or actuating equipment.

Complete, descriptive literature on Model #10 is available to you. Simply write and ask for Bulletin HM857.

See the Hoke-Manostat Model #10 at the ISA Show, Booth 1316, Cleveland Auditorium, September 9-13.

HOKE-MANOSTAT CORPORATION
148 SOUTH DEAN STREET
ENGLEWOOD, NEW JERSEY

For more information circle **131** on inquiry card.

NEW INSTRUMENTS

MINIATURE READ-OUT TUBE

New miniature Nixie converts electronic signals directly to readable characters, is a gas-filled cold-cathode 10-digit ("0" through "9"), numerical indicator tube for use as a direct in-line read-out device.—*Electronic Tube Div., Burroughs Corp., Plainfield, N. J.*

For more information circle **541** on inquiry card.

AC CONVERTER

New AC Converter module converts ac signals to dc voltages. When used with maker's DC Digital Voltmeter,

ratio of two ac signals can be automatically measured and displayed digitally.—*Electro Instruments, Inc., 3794 Rosecrans, San Diego, Calif.*

For more information circle **542** on inquiry card.

FREQUENCY CONVERTER

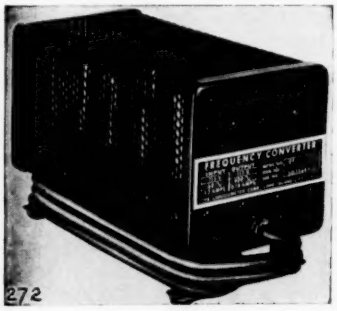
New Series 42 high-frequency low-time-constant converter for highly accurate readouts is capable of meas-

uring fluid flow transient changes within 0.75 millisec; is also of importance to tachometry to record undetected speed changes. Input frequency range 250-2500 cps.—*Potter Aeronautical Corp., Route #22, Union, N. J.*

For more information circle **543** on inquiry card.

FREQUENCY CONVERTER

New Frequency Converter makes 400-cps power available at any 60-cps outlet; over all dimensions 8½" x



5"; weight 3½ lbs; no moving parts; quiet in operation; supplies up to 20 watts.—*Liquidometer Corp., Long Island City 1, New York.*

For more information circle **544** on inquiry card.

OVERLOAD PROTECTOR

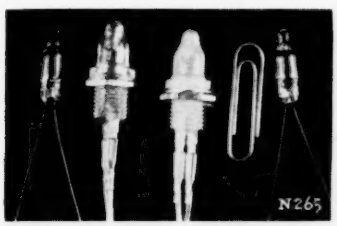
New instrument overload protector for permanent-magnet moving-coil movements protects against overloads

up to 1000% while affecting initial accuracy of instrument by less than 1%.—*Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles 39, Calif.*

For more information circle **545** on inquiry card.

POWER VOLTAGE INDICATOR

New assembly comprises an NE-2A lamp hermetically sealed in a completely molded nylon unit. The only



mounting hardware needed is nut and washer.—*Marco Industries Co., 207 S. Helena St., Anaheim, Calif.*

For more information circle **546** on inquiry card.

MULTI-PURPOSE VARIABLE TRANSFORMER

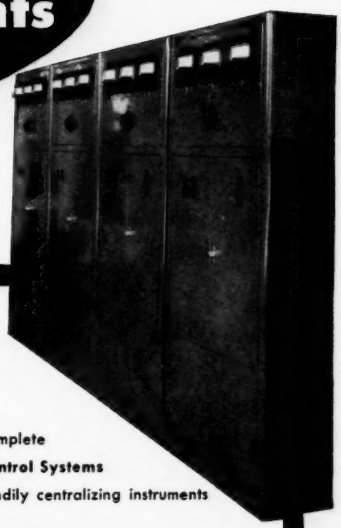
New Type 5-1011 miniaturized Powerstat variable transformer for high-frequency applications can be

used as a limited-range variable transformer, as a low-voltage-output variable transformer or as a line corrector on 400/1600-cps 1-phase service.—*The Superior Electric Company, 83 Laurel St., Bristol, Conn.*

For more information circle **547** on inquiry card.

Apart from a full line of Temperature CONTROLLERS

users have proved *these* instruments by WEST



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High Resistance indicating pyrometers

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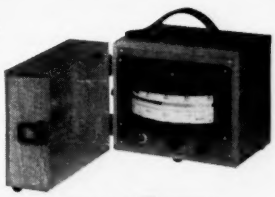
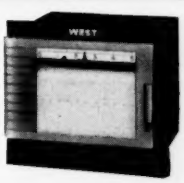


MODEL IE SERIES

Portable high resistance indicators

MODEL IN SERIES

Multi-Point indicators with TC switches



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For more information circle **132** on inquiry card.

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MOISTURE VAPOR HUMIDITY

CONTROL FOR COMPRESSED AIR

Van Air DRYER

Unique in moisture-control, Van-Air Dryers do more than trap condensed liquids from compressed air lines. They remove vapor-humidity to *LOW DEW POINTS* besides eliminating water and solid impurities from raw compressor air.

Van-Air Dryers eliminate elusive trace vapors that condense at line-extremity temperatures and cause untold product spoilage, instrument failure and operational down-time. Where air must be of clean, dry, instrument quality as in automation, product finishing, processing foods, chemicals, plastics, etc., these Dryers are proving highly efficient—*AND*, they work for pennies instead of dollars. Available in many capacities up to 5000 SCFM and pressures up to 3000 psi. Van-Air Dryers are used by hundreds of plants from coast to coast.

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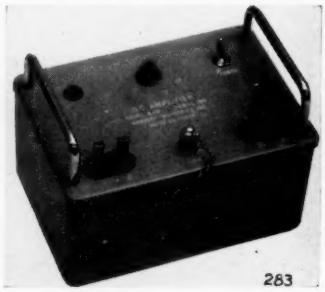
For more information circle **133** on inquiry card.

NEW INSTRUMENTS

AMPLIFIERS

PRE-AMPLIFIER

New M-10 d-c amplifier with chopper stabilization is specifically designed as a pre-amplifier for use with

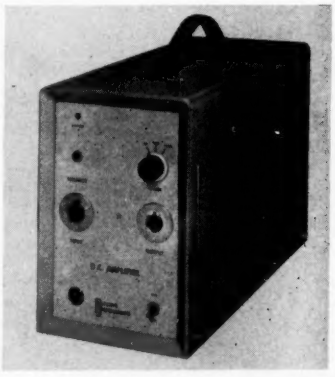


recorders of meter movement type. Input of 10 mv produces a 1.5 v output across a 1500-ohm load with 1% linearity, less than 1% zero drift, and 2% accuracy from dc to 2 cps.—*Industrial Instruments Div., Mandrel Industries, Inc., 5134 Glenmont Drive, Houston, Texas.*

For more information circle **548** on inquiry card.

DIFFERENTIAL DC AMPLIFIER

New DC Amplifier characterized by true differential input and output features provides extremely low noise

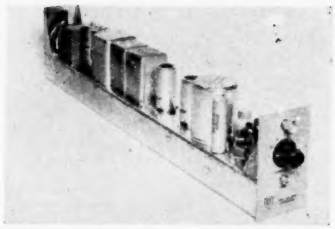


and drift characteristics with input impedance of 10,000 ohms. With line regulation, drift is less than 5 uv. gain steps from 0 to 1,000 with gain accuracy better than 1% at 2 kc. —*Electro Instruments Inc., 3794 Rosecrans St., San Diego, Calif.*

For more information circle **549** on inquiry card.

DC AMPLIFIER

New dc amplifier, said to be unique, features a true floating input for amplification of low-level signals from thermocouples, strain-gage bridges and resistance-bridge pickups. In Type 1-100c, input and output are isolated from each other and from ground. Amplifier utilizes a 400-cps chopper modulator. Gain is continu-



ously variable from 5 to 100, linearity is 0.05% of full scale; long-term stability is 0.2% of full scale; noise level is less than 5 microvolts peak-to-peak.—*Neff Instrument Corp., 2211 East Foothill Boulevard, Pasadena, Calif.*

For more information circle **550** on inquiry card.

POWER SUPPLIES

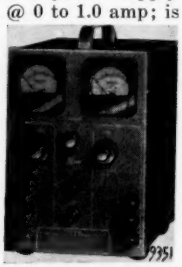
DC POWER SUPPLY

New Model C25 electronically regulated d-c power supply provides 300 v, 0-50 ma. Ripple is held to 1 millivolt. Regulation is 0.1% or better. Negative or positive output.—*Universal Electronics Co., 1720 22 St., Santa Monica, Calif.*

For more information circle **551** on inquiry card.

TRANSISTORIZED POWER SUPPLY

New Model 800-A dual transistorized power supply delivers 2 to 30 ▼ @ 0 to 1.0 amp; is said to have ripple

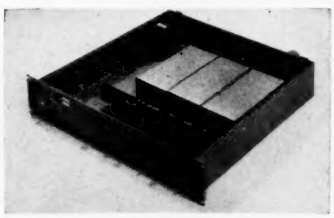


less than 500 μv, less than 0.01% variation in output voltage from no load to 1 amp and automatic short circuit and overload protection.—*Harrison Labs., Inc., Berkeley Heights, N J.*

For more information circle **552** on inquiry card.

STRAIN GAGE POWER SUPPLY

New Model PSG-3 provides three individual 6- or 10-v sources for 120- or 350-ohm strain gages. Three power



supply units are contained is a single chassis which fits standard 19" rack. Pushbutton switches on front panel allow sequential measurement of output voltage from each channel by an external voltmeter.—*KIN TEL (formerly Kay Lab), 5725 Kearny Villa Road, San Diego 11, Calif.*

For more information circle **553** on inquiry card.

RECTIFIERS

RECTIFIERS FOR SUPPLIES

New 170°C stud-mounted silicon rectifiers for power supplies feature reliability and uniformity of char-

acteristics over full life. Peak inverse voltage ratings 100, 200, 300 and 400 and maximum rms voltage ratings of 70, 140, 210, and 280 respectively. At 85°C, allowable dc output current rating is 1.5 amp.—*General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.*

For more information circle **554** on inquiry card.

SILICON RECTIFIER

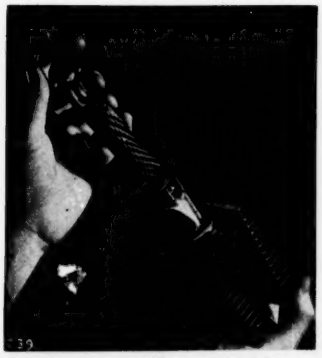
New 1Y rectifier provides full wave rectification, is efficient and durable, suitable for 110 vac input, 90 vdc out-

put; 0.9-amp capacity.—*Stearns Electric Corp., 120 North Broadway, Milwaukee 2, Wis.*

For more information circle **555** on inquiry card.

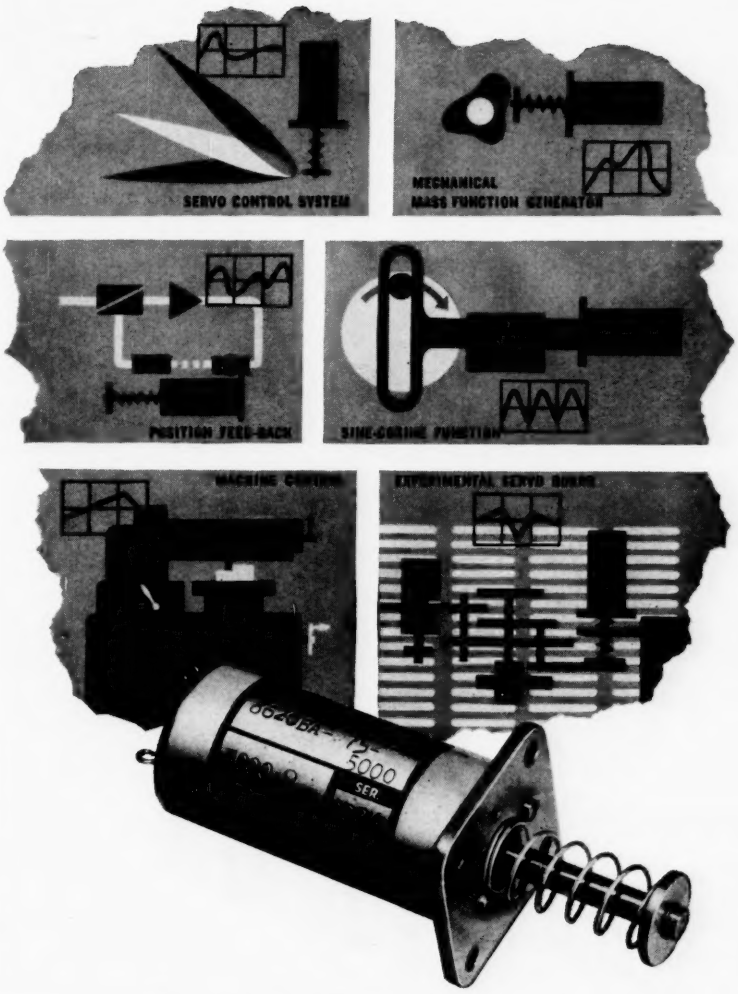
RECTIFIER JUNCTIONS

New germanium power rectifier junctions provide high reliability in heavy power applications; are rated



at 330 amps rectified output current at 20 to 66 volts rms.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **556** on inquiry card.



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Reliable enough for the most severe airborne environments, sensitive enough for precision laboratory work! There is a RECTIPOT rectilinear potentiometer for any application where control or measurement of linear motion is required.

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RESOLUTION: 0.001" to 0.003"
LINEARITY: ±0.5%
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For more information circle **134** on inquiry card.

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INSTRUMENT makers are using more and more Johnson pivots. Maybe you're one of them and can tell how many Johnson pivots are held in the teaspoon above.

There's a prize! No world beater, but a handy transistor portable radio to the closest guesser. In case of ties, earliest postmark will qualify.

But you needn't guess when you need precision pivots, accurately machined, scientifically hardened and polished to a metallographic finish. Direct your inquiry to Johnson for satisfaction.

Mail your estimate of the number of pivots in this regular teaspoon now to qualify for the prize. A postcard will do.

Welton V. Johnson
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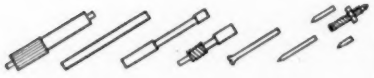

precision miniature parts

56 SUMMIT AVENUE

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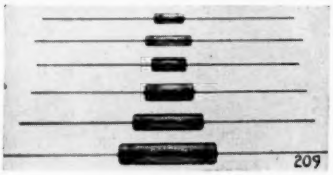
For more information circle **135** on inquiry card.

NEW INSTRUMENTS

RESISTORS

RS RESISTORS

Newly developed coating material greatly improves performance, particularly in withstanding thermal shock,

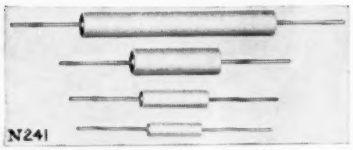


of precision wire wound RS type resistors.—*Dale Products, Inc., Columbus, Nebraska.*

For more information circle **557** on inquiry card.

CARBON FILM RESISTORS

New ceramic-encased precision resistor, recommended for use in instruments and HF circuits, features

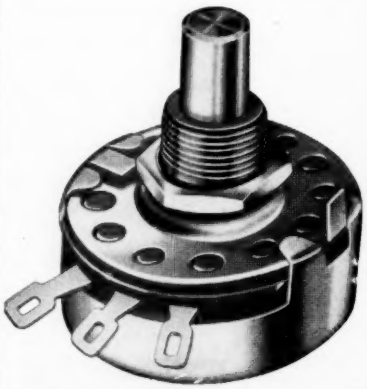


new type construction: a layer of pure carbon deposited on a ceramic rod; silver plated end-caps expansion-fitted for positive contact; unit encased in a non-hygroscopic ceramic tube and hermetically sealed with high-temperature solder.—*Continental Carbon, Div. Wirt Co., 5225 Green St., Philadelphia 44, Pa.*

For more information circle **558** on inquiry card.

VARIABLE RESISTOR

New Type K hot-molded composition variable resistor, designed to withstand ambient temperatures up to



150°C, is rated at 2 watts at 100°C ambient.—*Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.*

For more information circle **559** on inquiry card.

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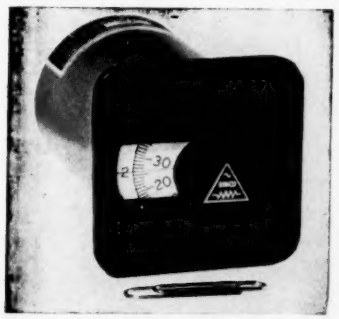
For more information circle **137** on inquiry card.

VOLTAGE-DIVIDING RESISTOR

New Type 49-A Verni-Pot vernier VDR is said to be "comparable to helical potentiometers." Standard re-



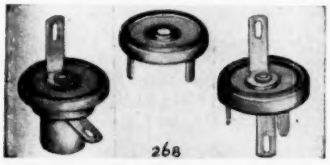
sistance ranges are 1000, 10,000 and 100,000 ohms; accuracy 5% of full scale resistance; linearity is 0.5% resolution 0.1%; power rating is 4 watts when used as a pot and 20 ma when used as a rheostat.—*Research Instrument Co., P. O. Box* 9168, *Portland* 16, *Oregon.*

For more information circle **560** on inquiry card.

CAPACITORS

HI-TEMP CAPACITORS

New custom-built High-Temperature Button Mica-Capacitors for continuous operation in 350°C range,

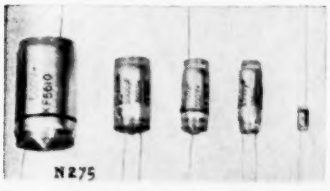


with test results over a range of −50°C to 350°C, show average change of less than 4% in capacitance and power factor.—*Erie Resistor Corp., Erie, Penna.*

For more information circle **561** on inquiry card.

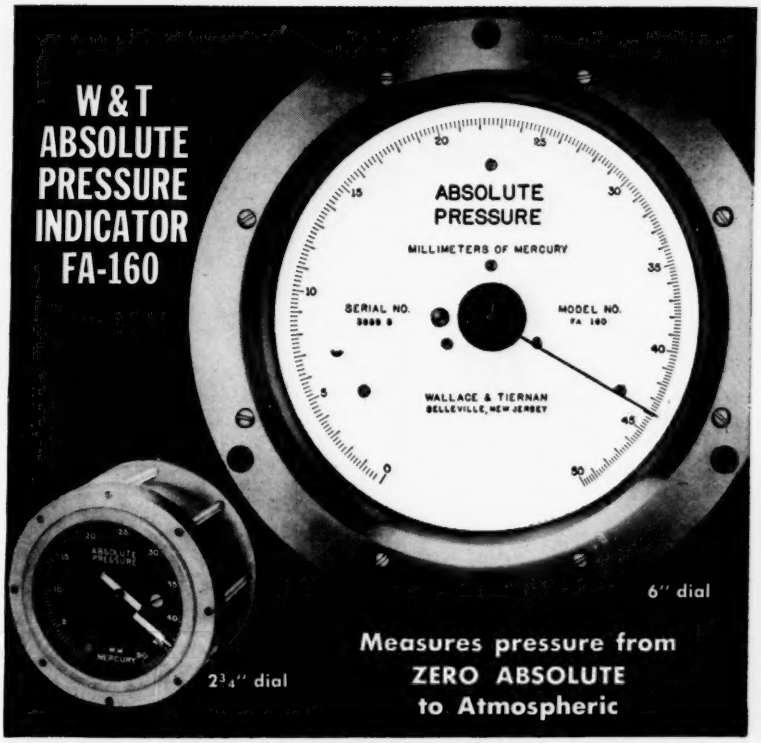
POLYSTERENE CAPACITORS

New "N.S.F." (Nurnberger Schraubenfabrik, Western Germany) fixed capacitors with dielectric of plastic



foils combine good electrical characteristics and small dimensions; operate at temperatures between −10°C and 70°C and in humidity up to 70% RH; are available in values from 5 mmfd to 0.025 mfd and ratings up to 500 vdc.—*Pimex, Inc.,* 2 *East* 82*nd St., New York* 28, *N. Y.*

For more information circle **562** on inquiry card.



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... For Precise Vacuum Work

Accuracy: 1/300 of full scale
Sensitivity: 1/500 in *all* ranges
Ranges: 0-50mm Hg. 0-100mm Hg.
0-200mm Hg. 0-410mm Hg.
0-800mm Hg. 390-800mm Hg.
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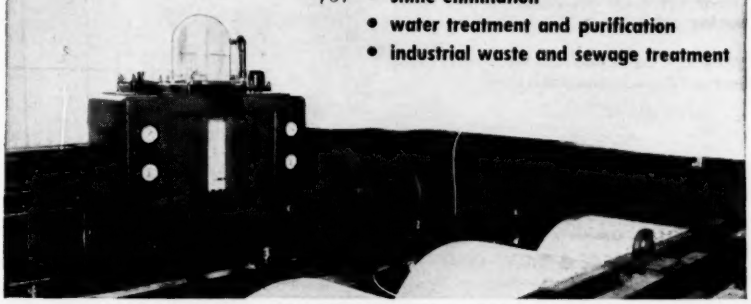

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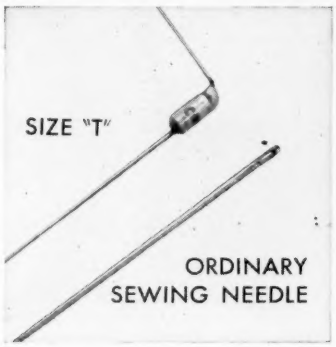
For more information circle **139** on inquiry card.

NEW INSTRUMENTS

TANTALUM CAPACITORS

Two new sizes Series TW (tantalum wire) of Tant-O-Mite electrolytic capacitors. Sizes "S" case dimensions



are $\frac{3}{16}$" L by $\frac{5}{64}$" D; size "T" measures $\frac{5}{32}$" L by 5/64" D.—*Ohmite Manufacturing Co., 3629 Howard St., Skokie, Illinois.*

For more information circle **563** on inquiry card.

SWITCHES

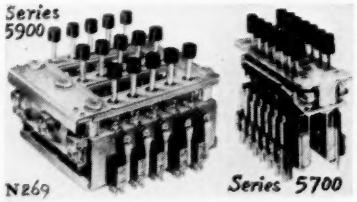
MERCURY SWITCH

New "CO-300" 3-amp 125-vac magnetically actuated mercury switch has contacts moved in or out of mercury by a 0.1-oz moving magnet, or electromagnetic field. No leads to flex and break; no organic components to contaminate mercury or contacts. Switch operates up to 60 times per second; will not starve out because of mercury condensation on walls; is said to make "ideal relay by simply adding a small coil and core."—*Hamlin, Inc., 1316 Sherman Ave., Evanston, Ill.*

For more information circle **564** on inquiry card.

INTERLOCKING SWITCHES

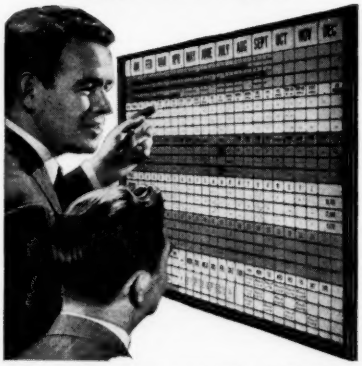
Two new types of interlocking push button switches are mounted in parallel row assemblies to provide



maximal number of interlocked stations: "Series 5900" is available with up to 36 interlocking stations, and "Series 5700" with up to 24. Each station can be equipped with various contact combinations.—*Donald P. Mossman, Inc., P. O. Box 265, Brewster, N. Y.*

For more information circle **565** on inquiry card.

How To Get Things Done Better And Faster



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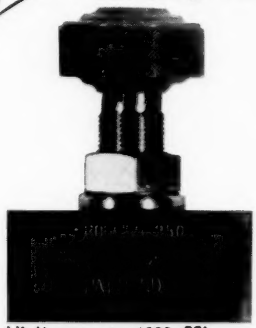
GRAPHIC SYSTEMS

55 West 42nd St. ● New York 36, N. Y.

For more information circle **140** on inquiry card.

ROBBINS **Leakproof Metering Valves**



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
- Lifetime Valve—can be completely overhauled in a matter of minutes without disturbing plumbing or mounting.
- The most economical valve in the long run.

Write for further details.

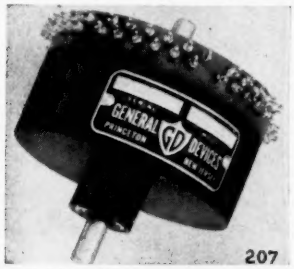
ROBBINS AVIATION

1735 W. Florence Ave.
Los Angeles 47, Calif.

For more information circle **141** on inquiry card.

SAMPLING SWITCH

New Series 160 precision switch with radial terminals designed for military and commercial applications

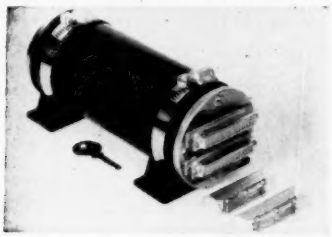


is available with one or two poles and up to 120 shorting channels or 60 non-shorting channels per pole.—*General Devices, Inc., P. O. Box 253, Princeton, N. J.*

For more information circle **566** on inquiry card.

TELEMETERING SWITCH

New Type AS multichannel sampling switch is designed for use in missile telemetering applications.



Sealed container allows switch to operate at altiudes up to 200,000 ft and in temperatures from 125°C down to −65°C. Available with from one to five poles with up to 60 contacts per pole, at sampling speeds ranging from 0.5 to 30 rps. Various motor drives available.—*Applied Science Corporation of Princeton, Princeton, N. J.*

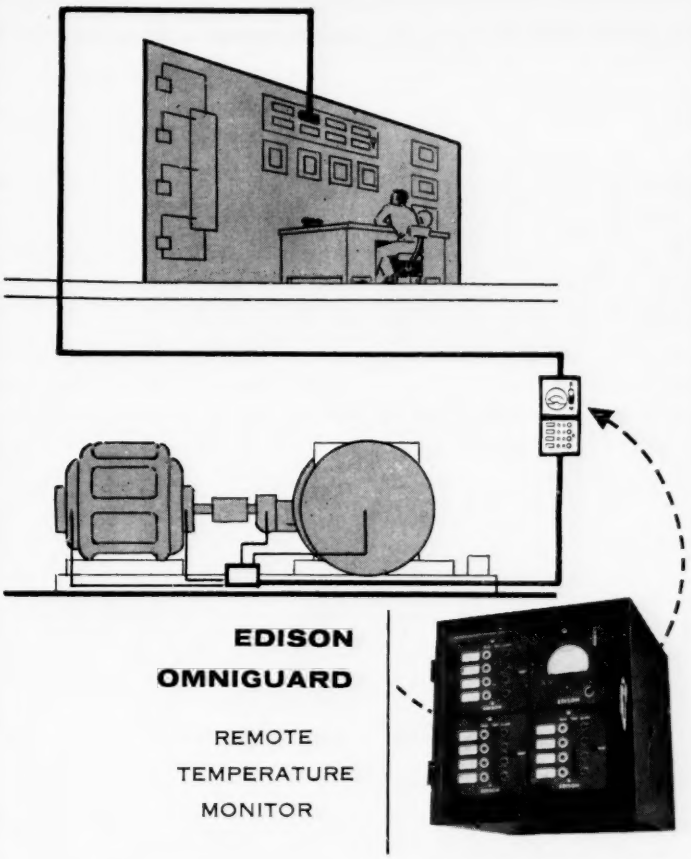
For more information circle **567** on inquiry card.

PUSH BUTTONS

New Bulletin 800 standard-duty push buttons and selector switches feature molded wrap-around cover

which contains and protects the contact mechanism.—*Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.*

For more information circle **568** on inquiry card.



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Wherever critical temperatures need constant watching . . . bearings, liquids, gases . . . OMNIGUARD indicating and alarm systems can save hundreds of man-hours, with greater accuracy and dependability than human checking could possibly render . . . and at a lower cost than any other system.

Omniguard watches temperatures continuously at distant, dangerous and often inaccessible points, eliminates human errors, makes possible longer and higher peak loads because warning is given before danger levels are reached. Note these outstanding advantages:

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- **One indicator serves multiple points.**
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Write for literature and specifications.

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Thomas A. Edison
INDUSTRIES
INSTRUMENT DIVISION
98 LAKESIDE AVENUE
WEST ORANGE, NEW JERSEY

For more information circle **142** on inquiry card.

NEW INSTRUMENTS

SAMPLING SWITCH

New Model AN-00007 hermetically sealed sampling switch designed for use in a target designation system for fighter aircraft at temperatures from −65°C to 85°C at altitudes up to 70,000 feet.—*Applied Science Corporation of Princeton, Princeton, N. J.*

For more information circle **569** on inquiry card.

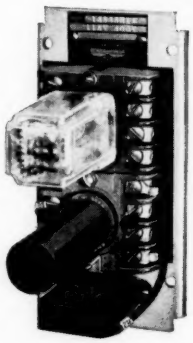
RELAYS

SUPERSENSITIVE RELAYS

New improved low-cost "meter relays" feature a simplified design, with platinum alloy contacts and increased contact force, which minimizes sticking and maximizes reliability. Operating on power inputs of less than 50 millimicrowatts, new relays will control up to 1w (power amplification of 20 million); are a non-locking type.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **571** on inquiry card.

AC SENSITIVE RELAY



New ac sensitive relay with transistor amplifier resists vibration, corrosion and shock. Standard features include 2pdt plug-in relay protected by clear polystyrene dustproof cover; long life plug-in transistor amplifier and power pack module; 12 vdc sensing circuit and low sensing circuit current (less than 2 ma). No warm-up time required. Convenient terminal board for making external connections. Rated up to 10 amp 110 v 60 cps; available in open type panel or NEMA type 1 bonderized enclosure.—*Cutler-Hammer, Inc., 503 N. 12th Street, Milwaukee, Wis.*

For more information circle **570** on inquiry card.

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON

HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

A COMPLETE LINE OF HATCHET IRONS BY HEXACON —*Originator and Pioneer*

CAT. NO.	WATTS	TIP DIA.	PRICE
25H	25	1/8"	$ 6.50
26H	30	3/16"	6.50
30H	60	1/4"	6.75
70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
300H	300	7/8"	18.25

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INDUSTRY'S No 1 HEXACON SOLDERING IRON

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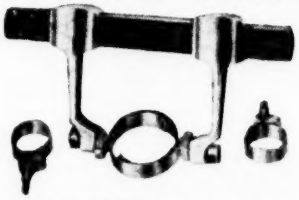
For more information circle **144** on inquiry card.

THE ROLYN
(Snake) Plier

An indispensable tool for assembly and dismantling of optical, radio, scientific instruments and all kinds of mechanical equipment.



The SNAKE PLIER consists of two coil springs with their turns interleaved, attached to two arms projecting from and sliding for adjustment of diameter on the main supporting bar. Two sets of springs are supplied and additional sizes are available.

Ideal for use in all fields where a positive friction grip is required in loosening, or tightening, of the most delicate and fragile threads, or thin wall tubing without danger of damaging, or of marking. Can be used on right or left hand threads. It is equally effective at any angle.

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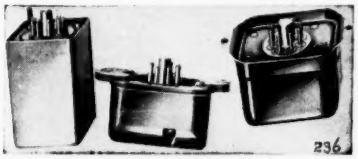
For more information circle **145** on inquiry card.

D-C POLAR RELAY

New MYZA transistorized polar relay has built-in transistor preampli-



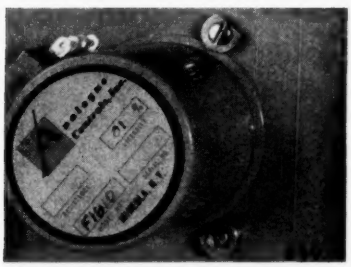
fier, requiring minimal input power to operate the contacts.—*Barber-Colman Co., Rockford, Ill.*

For more information circle **572** on inquiry card.

MECHANICAL COMPONENTS

QUICK-RELEASE CLAMP

New Synclamp is a standard clamp designed to meet governmental shock, vibration and environmental tests; re-

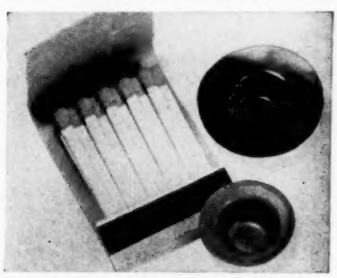


quires no special tools or manual dexterity.—*Timber-Top, Inc., P. O. Box 14, Freeport, N. Y.*

For more information circle **573** on inquiry card.

MINIATURE DIAPHRAGM SEALS

New Miniature Diaphragm seals, having cylinder bore diameters of ½" to 1", have been added to maker's



basic group of 1" to 6" diameter piston seals.—*Bellofram Corp., Burlington, Mass.*

For more information circle **574** on inquiry card.

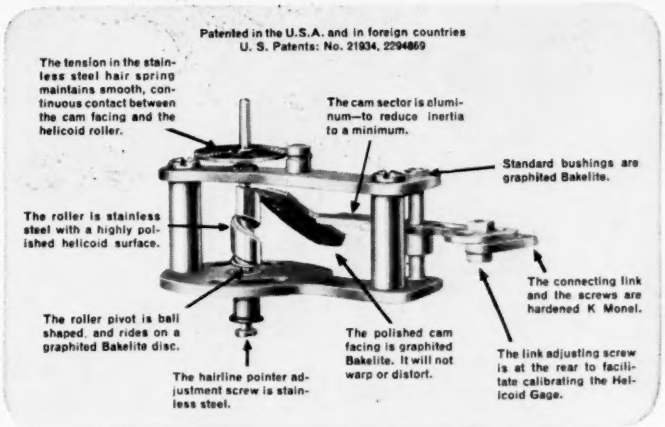
TEFLON TUBING

New Teflon tubing with axial stripes of any color including combinations is available in any size. Stripes penetrate full depth of tubing. —*Pennsylvania Fluorocarbon Company, Inc., 1115 North 38th St., Philadelphia 4, Pa.*

For more information circle **575** on inquiry card.

Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials —alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

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ACCO
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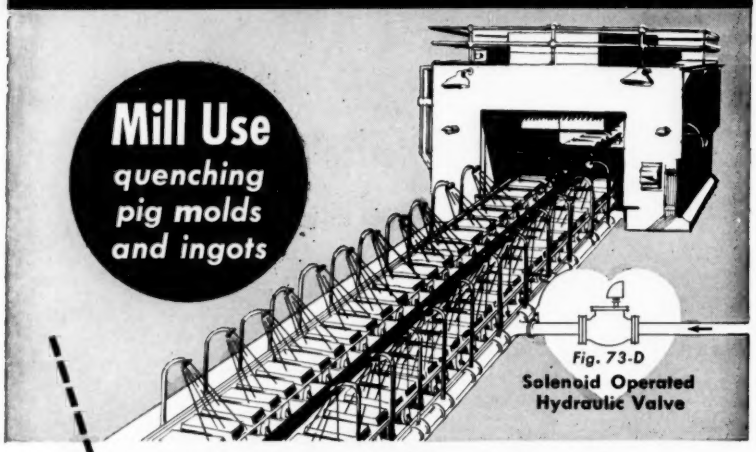
For more information circle **146** on inquiry card.

GOLDEN-ANDERSON VALVES IN ACTION!



For automatic quenching of pig molds (illustrated above) or ingots, install the G-A Cushioned Solenoid-Operated Valve. This valve opens quickly, closes at adjustable speed without hammer or shock, is available either normally closed or normally open, and is actuated automatically by push button, trip switch on conveyor, or other type of limit switch.

Available in either Angle or Globe Body Pattern

Write for descriptive technical bulletin W-7A.

Golden Anderson Valve Specialty Company
1286 RIDGE AVE., PITTSBURGH 33, PA.

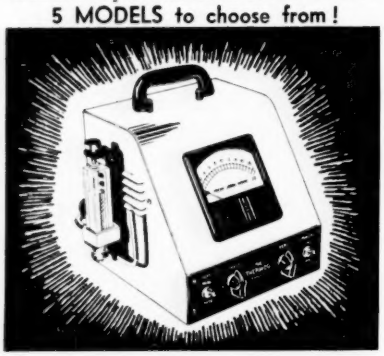
For more information circle **147** on inquiry card.

SAVE FUEL DOLLARS

PORTABLE FLUE GAS ANALYZER

COMPLETE CO_2 READING TAKES ONLY 20 SECONDS

5 MODELS to choose from!



THE THERMCO ANALYZER IS A PROVEN INSTRUMENT FOR QUICKLY ADJUSTING ALL TYPES OF BOILERS AND HEATERS FOR MAXIMUM EFFICIENCY. CONSIDERABLE TIME SAVED OVER THE CHEMICAL METHOD, AND THE FINAL RESULTS ARE FAR MORE SATISFACTORY.

SEND TO-DAY: Complete facts on how to SAVE FUEL DOLLARS and maintenance man hours!

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For more information circle **148** on inquiry card.

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SAPPHIRE JEWELS...

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THREAD GUIDES
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GAGES
WEAR PARTS
STYLII

JOHN WORLEY JEWEL CO.

No. Falmouth, Massachusetts

For more information circle **149** on inquiry card.

NEW INSTRUMENTS

BELLOWS

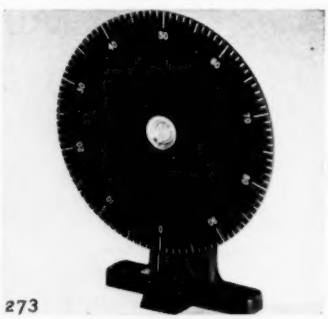
New "Formset" bellows were developed to fill the need for precision metal bellows in miniaturized com-

ponents and also for aircraft parts where space is at a premium.—*Bridgeport Thermostat Division, Robertshaw-Fulton Controls Co., Milford, Conn.*

For more information circle **576** on inquiry card.

DIAL ASSEMBLY

New BP-532 Dial Assembly, black anodized 3" aluminum disc, designed for low mass and inertia, is easy to

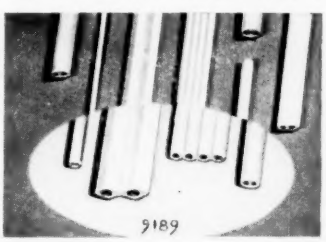


read. Bore diameter ¼". Dials with 100 and 360 divisions carried in stock for immediate delivery.—*Beckman/Helipot Corp., Newport Beach, Calif.*

For more information circle **577** on inquiry card.

ALUMINA TUBING

New minute yet strong "AlSiMag Alumina Tubing" is available in unconventional cross-sections some re-



sembling figure 8's, others with 4 or more holes like figure 8's in tandem. Each tubular unit can be joined closely to its neighbor, or separated by "ceramic webbing" of various widths and thickness, whence a cross section like a dumbell. Such designs have particular value for dissipating heat.—*American Lava Corp., Cherokee Blvd. & Manufacturers Road, Chattanooga 5, Tenn.*

For more information circle **578** on inquiry card.

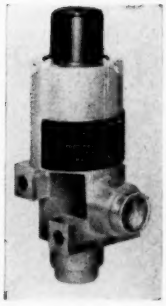
VALVES

SOLENOID-CONTROLLED VALVE

New pilot-operated in-line poppet-type 3-way air valve meets all JIC Standards, including 4 water tight and dust-tight solenoid enclosures; features recessed pin which can be locked in or locked out to operate valve manually. ¼" to 1¼" sizes, n-o or n-c with continuous duty solenoids.—*Automatic Valve Co.*, 37415 *Grand River Ave., Farmington, Mich.*

For more information circle **579** on inquiry card.

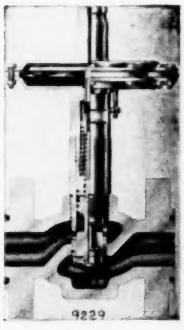
SHUT-OFF VALVE



New MV-126B Miniature Solenoid Shut-off Valve, completely free of dependence upon moving seals, features low pressure drop—4 psi at 2.1 ppm. flow; is operated by a 24 vdc 1 amp power supply at pressures from 0 to 500 psi and temperatures from —65°F to 350°F.—*Marotta Valve Corp.*, 330-50 *Boonton Ave., Boonton, N. J.*

For more information circle **580** on inquiry card.

DIAPHRAGM CONTROL VALVE

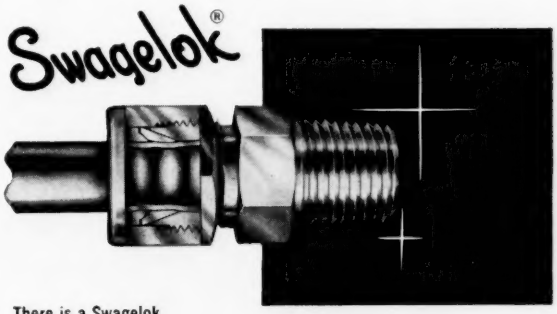


New "Type DCB-1" is guaranteed to give bubble-tight closure against line pressures up to 10,000 psi; features a completely pressure-balanced disk, unaffected by line pressure either on opening or closing movement, which permits valve to be operated with supply air as low as 3 psi with a single seat and one 8" diaphragm. Inner valve, including seat, is accessible from top of valve and can be removed and replaced without breaking line connections. Sizes from 2" through 4"; screwed or flanged connections; with "controller top mount" (illus) or with ¼" NPT top connection.—*Garrett Oil Tools, Inc., P. O. Box* 2427, *Longview, Texas.*

For more information circle **581** on inquiry card.

Only one name identifies the finest in fittings

Swagelok®



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For catalog, write Dept. A-6

TUBE FITTINGS

CRAWFORD FITTING COMPANY

884 East 140th Street

Cleveland 10, Ohio

For more information circle **150** on inquiry card.

7000 SOLD in 7 YEARS!

That's the Field-Tested record of the

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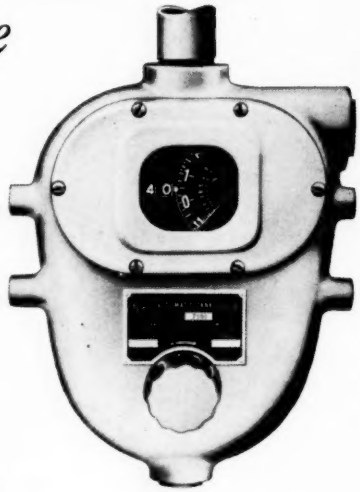
FIGURE NO. 2500 SERIES



AUTOMATIC TANK GAUGE

Patent No. 1,879,805
Patent No. 2,555,593
Other Patents Pending

Seven solid years of proven service stand behind the "Varec" Fig. 2500 AUTOMATIC TANK GAUGE. It was first with the NEG'ATOR MOTOR – a feature so good that competition copies. It's not new it's been tested for seven years. Because it is a long-deflection constant force element it is *not* a spring – It is a motor!

When you have to squint into a look-box, even if the gauge tape is clean, you are subject to parallax – (if you are tall, you read the tape *low*; if you are short you read the tape *high* . . . that's parallax). A mis-reading of 1/8 inch can cost you or your customer many barrels of oil on a large tank. Accuracy is assured with the "Varec" Counter and Dial System (Patent claim allowed but not yet issued – other patents pending). Gravity Compensator adjustments made at counter assembly without exposure to tank vapor or pressure. Tank vapors sealed off from counter assembly. Removal of front cover plate will not de-pressure tank. Patented operation checker for testing gauge operation.

There is a Fig. 2500 Series gauge for every type of installation.

Tell your "Varec" representative your gauging problem, our Engineering Department will come up with the correct answer. You will have a gauge that leads the field – that stands for quality and accuracy first and it will cut your "unaccountable losses." That's why the "Varec" Fig. 2500 has a fast "pay-out."

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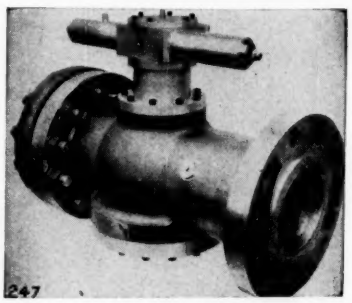
For more information circle **151** on inquiry card.

NEW INSTRUMENTS

CONTROL VALVES

New 8" ball-type control valves, for systems up to 2000 psi and temperatures up to 225°F, are controlled by

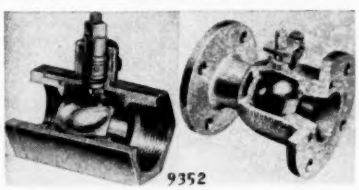


a pressure-operated actuator, feature rapid response characteristics.—*Hydromatics, Inc., Cedar Grove, N. J.*

For more information circle **582** on inquiry card.

BALL VALVES

New 3" and 4" "double seal" ball valves are said to eliminate high turbulence and leakage; give full-flow;

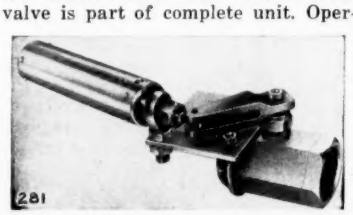


have quarter-turn operation; are made in aluminum, bronze, 316 stainless steel and carbon steel. Seat and seals available in Buna-N, Neoprene, Teflon and synthetic rubbers. Remote-controlled actuators can be supplied. —*Jamesbury Corp., 45 New Street, Worcester, Mass.*

For more information circle **583** on inquiry card.

CONTROLLED BALL VALVES

New Remote Operator is announced for Double Seal Ball Valve. Pilot valve is part of complete unit. Oper-



ator is front-end mounted in a spherical bearing to absorb thrust load and permit motion. Piston rod strokes provide exact open and shut position. Speeds range from ½ sec for a ¼" valve to ¾ sec for 1¼" to 4" valves. Speeds can be increased or decreased. Continuous duty up to 100 cycles per minute.—*Jamesbury Corp., 45 New Street, Worcester, Mass.*

For more information circle **584** on inquiry card.

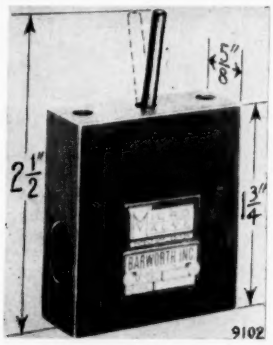
PVC LIFT CHECK VALVE

New all-polyvinyl chloride lift check valve, for chemical and petroleum fields, will operate in vertical or horizontal position, and open and close under less than 6 psi pressure; provides full 100% flow area. Only moving part is a self-energizing disc. Available in ½" to 3" sizes, in threaded or socket welding types. Material is normal impact PVC.—*Tube Turns Plastics, Inc., Louisville, Ky.*

For more information circle **585** on inquiry card.

SMALL SNAP-ACTION VALVE

New "Model 167 Micro Valve" has ¼" NPT ports at sides and bottom, functions as either a 2-way shut-off or

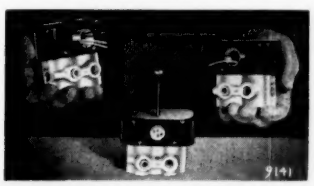


as a 3-way control depending on which port is blocked; employs a unique snap-action toggle which remains in selected position; will find many applications, especially in eliminating need for combinations of limit switches and solenoid pilots.—*Barworth, Inc., 7 Industrial Place, Summit, N. J.*

For more information circle **586** on inquiry card.

FOUR-WAY VALVES

Three new "Quick-Dump" control valves for operation of double-action cylinders are 4-way, 5-port units



utilizing maker's "Quick-Dump" valving mechanism: no internal springs, packings, pistons, or sliding metal-to-metal contacts. Valving action is said to be ultra-fast and positive, with dead-seal closing. Two of new valves are electrically operated; employ, instead of solenoid, a new type electromagnetic armature with short throw (0.022") which prevents hammering. Hand lever valve is designed for mounting on machine, at production-line station, etc.; "holds" at either forward or back position of lever.—*Humphrey Products Div., General Gas Light Co., Kalamazoo, Mich.*

For more information circle **587** on inquiry card.

Universal RELAY CORP.

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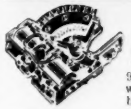

STEPPING SWITCHES

SS5 Minor Switch 10 steps and off. Contacts: Nos. R960, 975, 976 Gold plated brass; Bridging wiper; others beryllium-copper. Non-bridging wiper; Net Wt. 1 lb.

VOLTS DC	Stk #	1 level Price*
6- 12	R960	9.50
24- 36	R975	10.50
48- 60	R976	11.50
100-125	R643	12.50
VOLTS DC	**Stk #**	**2 level Price***
6- 12	R977	10.50
24- 36	R978	11.50
48- 60	R979	12.50
100-125	R644	13.50
VOLTS DC	**Stk #**	**3 level Price***
6- 12	R642	11.50
24- 36	R600	12.50
48- 60	R645	13.50
100-125	R646	14.50

SS6 Western Electric Co.; 22 step; 5 levels; Bridging wipers; Contacts; Gold plated brass. Interrupter Switch: 1 Break-Make; Net weight: 2 lb. 2 oz. "Homing" type; 180° Wipers; Step in One Direction.

		ea*
# R926;	6 to 12 VDC	13.75
# R980;	24 to 36 VDC	14.75
# R981;	48 to 60 VDC	15.75
# R615;	100 to 125 VDC	16.75

SS7 Western Electric Co.; 44 step; 2 Circuit Bridging Wipers; Contacts; Gold plated brass; Interrupter Switch: 1 Break-Make; Net weight: 1 lb. 14 oz. "Homing" Type; 360° Wipers; Step in One Direction.

		ea*
# R927;	6 to 12 VDC	13.75
# R982;	24 to 36 VDC	14.75
# R983;	48 to 60 VDC	15.75
# R616;	100 to 125 VDC	16.75

AUTOMATIC ELECTRIC Type 45

50 step; Five levels; Non-Bridging wipers. Contacts: Beryllium Copper. Break-Make Interrupter; Break-Make Off-Normal Springs.

# R893	6- 12 VDC		27.50
# R894	24- 36 VDC		28.50
# R895	48- 60 VDC		29.50
# R896	100-125 VDC		31.00
# R1310	With Rectifier for 110 V AC Operation		35.00

MERCURY WETTED CONTACT RELAYS

- **LONG LIFE:** Conservative life expectancy of over a billion operations when operated within ratings.
- **HIGH SPEED:** Give consistent performance at speeds up to 60 operations per second.
- **HIGH CURRENT**—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).
- **CHATTER-FREE:** Mercury dampens armature vibration and bridges mechanical chatter between metal contact surfaces.

WESTERN ELECTRIC D168479; (Equivalent to 275C); SPDT; 2 coils; 3300 and 700 ohms; High pressure sealed; Octal plug base. Operating current: Windings in series, 6.6 ma. release: 5.2
R1022 ..... 10.00*

C P CLARE HGP1010: SPDT, Double Break (1W); 2 coils—1020 and 970 ohms; high pressure; hydrogen sealed; octal plug base. Operates with 15 ma on either coil; magnetic bias for operation between narrow limits;
R1026 ..... 10.00*

PRECISION 400 CYCLE CHOPPER RUMPLE C102

Conforms to MIL-E-5757B, MIL-E-5272, and others; Weighs less than 6 oz.; 2⅝" L x 1 9/16" D. Standard Octal base. 6.3V Drive; SPDT.
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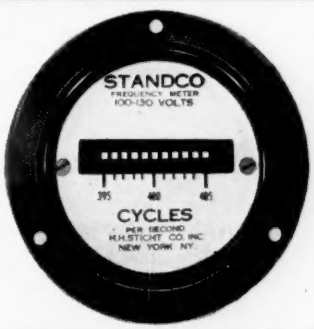

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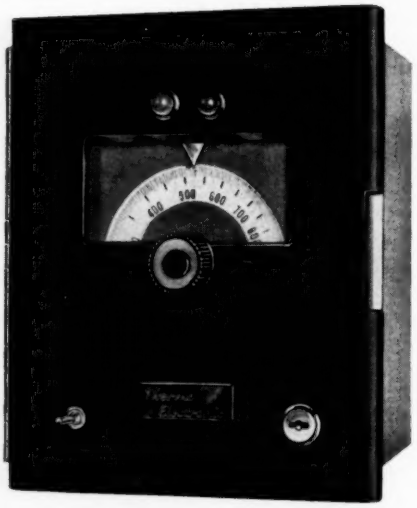
For more information circle **154** on inquiry card.

New, *Transistorized* Temperature Controller



Provides

Much Greater Sensitivity

Long Life, Lower Maintenance

Use of **transistors,** rather than electronic tubes, in this ON-OFF signalling controller provides a tremendous increase in both the life and dependability of the instrument. Ruggedly constructed, it can withstand severe conditions of vibration and shock without loss of sensitivity or accuracy. Maintenance, naturally, is sharply reduced.

Available for either thermocouples or resistance bulbs, this transistorized controller also provides greatly increased sensitivity – acting on a temperature change of but ½°F. Use of regular A.C. line voltage eliminates the need of a standard cell and battery. **Periodic standardizing** to maintain factory accuracy of the null balance measuring circuit **is no longer necessary.** Calibration accuracy is guaranteed to within ¼ of 1% of scale span. Scale ranges are available for all standard calibrations – covering temperatures from minus 320°F. to plus 3000°F.

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SADDLE BROOK, NEW JERSEY
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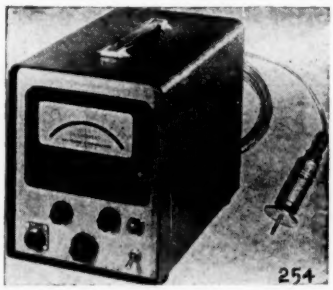
For more information circle **155** on inquiry card.

MISCELLANEOUS

SIZE & POSITION INDICATOR

New Model 300 Displacement Indicator features three calibrated ranges of plus and minus 0.1", 0.01"

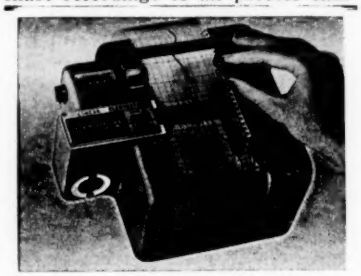


and 0.001" full-scale; accuracy to 0.00001".—*Daytronic Corp., 216 S. Main St., Dayton 2, Ohio.*

For more information circle **588** on inquiry card.

PLANIMETER

New Model 601 Linear Planimeter can be used for integrating data from chart recordings of all process char-

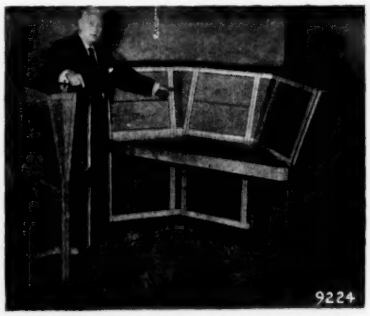


acteristics; also control system characteristics; accepts chart sizes up to $3\frac{7}{16}$"; can handle 2 ft of chart (24 hours of recording) in 15 seconds, with optimum accuracy of 0.1%.—*Librascope, Inc., Glendale, Calif.*

For more information circle **589** on inquiry card.

WEDGE CABINET

New wedge-shaped cabinet groups rectangular cabinets or racks in one semicircular "organ console" arrange-



ment; is available in 30°, 45° or 60° units.—*Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill.*

For more information circle **590** on inquiry card.

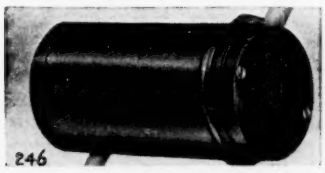
SULFURIC ACID DISPENSER

New safety equipment avoids lost-time accidents and safe guards handling H_2SO_4, insures more uniform results and greatly reduces processing time. Models available handle capacities from 8 to 24 gph. A smaller dispenser covers capacities ranging from 0.8 to 8.0 gph.—*Proportioneers, Inc., 345 Harris Avenue, Providence 1, R. I.*

For more information circle **591** on inquiry card.

INTEGRATING GYROS

New Series 101G high precision subminiature floated integrating gyros are so small that three can be



mounted in a 3⅛" sphere.—*Reeves Instrument Corp., Dynamics Corp. of America, 25 West 43rd St., New York 36, N. Y.*

For more information circle **592** on inquiry card.

LIQUID SPRING

New Model 1099 utilizing liquid compressibility and built into a bolt is said to be "revolutionary." Designed to permit spring action to be built within a structure; spring is built within a bolt used in an existing machine. It has a low spring rate of 500 lb preload and 1000 lb end load with 2½" stroke. Other liquid springs from ½" to 6" dia with forces from 200 to 125,000 lb.—*Taylor Devices Inc., 188 Main St., North Tonawanda, N. Y.*

For more information circle **593** on inquiry card.

KLYSTRON TRANSMITTER

New Model G154 30-megawatt S-band klystron transmitter utilizes a Varian VA-814 30-megawatt S-band

klystron; operates at a fixed pulse length of 2 usec at 60 pps. Complete r-f output waveguide assembly and stainless-steel dummy load is continuously evacuated to handle 30-Mw peaks; includes a 53.7 db and a 63.4 db directional coupler along with crystal and thermistor detector mounts.—*Levinthal Electronic Products, Inc., 905 Stanford Industrial Park, Palo Alto, Calif.*

For more information circle **594** on inquiry card.

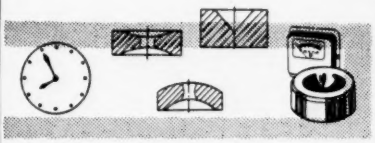
PRECISION

defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

Swiss American



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Cat. No. 314 45-18,000 RPM
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Bulletin 751

"JAQUET" SPEED INDICATORS (CHRONOMETRIC)

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Bulletin 770

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FREED MAGNETIC AMPLIFIERS

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FAST RESPONSE MAGNETIC AMPLIFIERS
2∿ response — Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	AC or DC signal voltage req'd for full output.	
MAF-1	60	13	110	1.0	—
MAF-6	400	5	57.5	1.2	0.4
	400	10	57.5	1.8	0.6
MAF-7	400	15	57.5	2.5	1.0

PUSH-PULL MAGNETIC AMPLIFIERS
Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. KΩ
MAP-1	60	5	115	1.2	1.2
MAP-2	60	15	115	1.8	2.4
MAP-3	60	50	115	2.0	0.5
MAP-3-A	60	50	115	7.0	2.9
MAP-4	60	175	115	8.0	6.0
MAP-7	400	15	115	0.6	2.8
MAP-8	400	50	110	1.75	0.8

All units designed for 115V-AC operation

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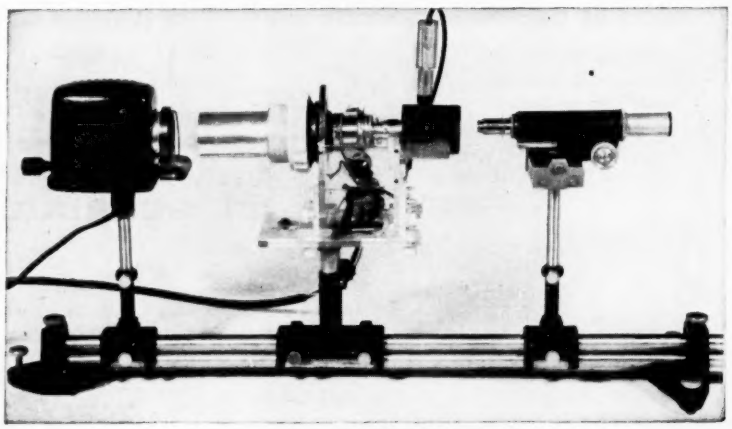
A NEW APPROACH TO THE PROBLEMS OF INSTRUMENTATION



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Universal Instrument Bench Div.

551 East 179th St. New York 57, New York.

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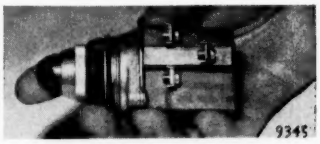
NEW INSTRUMENTS

"PUSH-TO-TEST" LAMP

New push-to-test indicating light unit provides quick positive method of testing burned-out lamp bulbs on

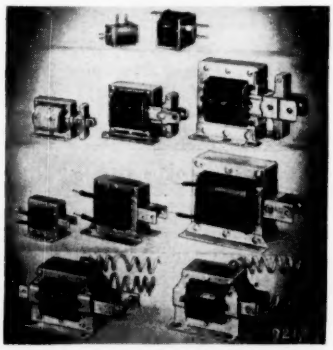


control panels and push-button stations.—*General Electric Co., General Purpose Control Dept., Schenectady 5, N. Y.*

For more information circle **595** on inquiry card.

CUSTOM SOLENOIDS

New line of custom-designed stock solenoids offering delivery within 24 hours of receipt of order comprises

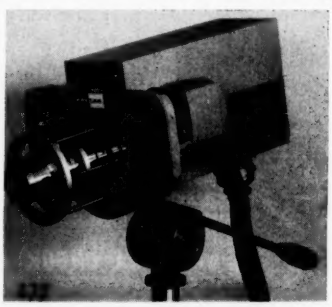


17 models to provide 34 different specifications. Pull and/or push capacities up to 45 lb; sizes from 1⅝" by -1⅜" to 3" x 3", stroke lengths fractional to 2". Any quantity from single units to production orders.—*Dormeyer Industries, Dept. IUP, 3418 N. Milwaukee Ave., Chicago 41, Ill.*

For more information circle **596** on inquiry card.

REMOTELY CONTROLLED IRIS-FOCUS UNIT

New Model ARC-1 provides vibration-free remote control of TV camera lens aperture and focus. Both op-



erations are accomplished simultaneously from a small modular control panel.—*KIN TEL (formerly Kay Lab), 5725 Kearny Villa Road, San Diego 11, California.*

For more information circle **597** on inquiry card.

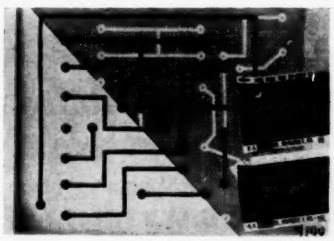
AIR LINE FILTERS

New Automatic-Drain Air Line Filters, with simplified design of drain mechanism, feature wide pressure and temperature operating range; operate at top efficiency at air line pressures as low as 5 psi for all models, as high as 150 psi for transparent bowl models and 250 psi for new metal bowl type. They drain automatically.—*C. A. Norgren Co.*, 3400 *So. Elati St., Englewood, Colorado.*

For more information circle **598** on inquiry card.

DRAFTING-AID SHAPES

New "Black 'N White" drafting aids cuts printed-circuit layout time, are "two-colored" pre-cut self stick-

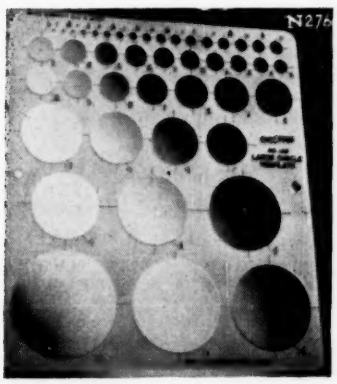


ing shapes used for making layouts on clear or translucent film or cloth. Circuitry is laid out on both sides of sheet. Pre-cut shapes and terminal strips have a white adhesive side and a black non-reflective top side.—*W. H. Brady Co.*, 727 *W. Glendale Ave., Milwaukee* 9, *Wis.*

For more information circle **599** on inquiry card.

LARGE-CIRCLE TEMPLATE

New "No. 140," 8¼" x 7¼", has 45 circles from $\frac{1}{16}$" to 2¼", increments 64ths to 11/32", 32nds to ¾", 16ths



to 1" and 8ths to 2¼". Each circle is individually milled for utmost smoothness. Pencil allowance assures accuracy.—*Rapidesign, Inc., Box* 592, *Glendale, Calif.*

For more information circle **600** on inquiry card.

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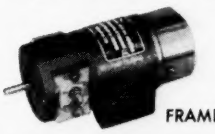
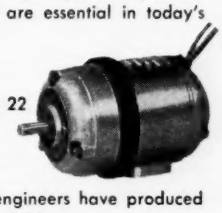
Instrument Motors' policy of precision fabrication for each customer's specific requirements is attainable because of our engineering staff's long experience with rotating components. At the same time we constantly stress quality, lowest possible costs and fastest deliveries, which are essential in today's competitive industrial market.



FRAME 16



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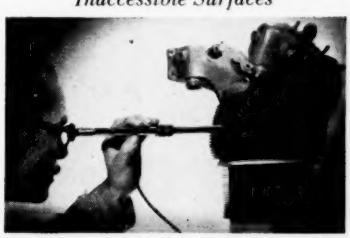

Provides "inner eye" for inspection of combustion and compression engines, for oil and gas tanks, for hollow castings or bearings, for all internal surfaces which are dark and allow access only through a hole as small as ½". Used by leading aircraft and industrial companies.

Built-in illumination. Contains 12 highly corrected, achromatized, fluoride-coated lenses. Magnification varies with distance—from 2x at 12" to 6.25x at 3".

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From 3" to 60" in length
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Taper to within .000030" and better
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Surface finish—as specified, including optical finish

Work done in—
Hard Chrome Plate
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For more information circle **162** on inquiry card.

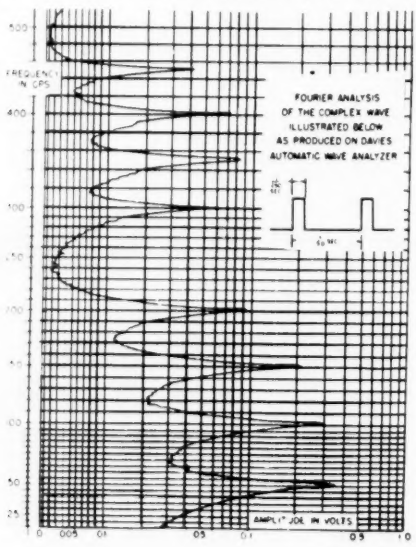
INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

Automatic Wave Analyzer

Automatic wave analyzers provide an ideal method for reducing analog data . . . a complete Fourier series can be automatically plotted as either amplitude vs frequency or power vs frequency . . . much faster than digital analysis.

The 9020P Analyzer consists of a very stable tunable oscillator covering the range of 3,000 to 5,000 cps, a balanced



TYPICAL ANALYSIS

ring modulator, a fixed frequency tuned amplifier centered at 3,000 cps, and adjustable in bandwidth from ½ cps to 45 cps, a rectifier, and a specially modified Brown ElectroniK strip chart potentiometer.

The signal to be analyzed is fed into the "modulator-filter" where it is mixed with the sweeping frequency of the variable oscillator from the "oscillator controller." Mixing of these two frequencies produces the upper and lower sidebands of the frequency from the varied oscillator (heterodyning). When the lower sideband is equal to 3 kc it will be accepted by a selective 3 kc tuned amplifier where it is amplified. It then is rectified and recorded since the sideband amplitude is directly proportional to the amplitude of the component in the input signal . . . (*From new* 4-*page Bulletin* 9001, *Minneapolis-Honeywell Reg. Co., Davies Laboratories Div.*, 10721 *Hanna St., Beltsville, Md.*)

For this literature circle **601** on inquiry card.

Transistor Interchangeability Chart

TRANSISTOR INTERCHANGEABILITY CHART

TYPE NUMBER	COMPARABLE GT TYPE NO.	TYPE NUMBER	COMPARABLE GT TYPE NO.	TYPE NUMBER	COMPARABLE GT TYPE NO
2N34	2N34	2N140	GT-761	2N317	2N317
2N35	GT-35/(2N35)	2N167	GT-167	2N318	2N318/GT-66
2N36	GT-20	2N175	GT-81	2T11	GT-34
2N37	GT-14	2N180	GT-109, GT-81HS	2T12	GT-14
2N38	2N38	2N182	GT-904B	2T13	GT-14
2N38A	GT-14H	2N183	GT-792	2T14	GT-222
2N41	GT-81H	2N185	GT-109	2T51	GT-904

α_F, α_{FB}, α_{FC}, α_{FE}.— The static value of the short-circuit forward current transfer ratio.[2]

α_f, α_{fb}, α_{fc}, α_{fe}.— The small-signal short-circuit forward current transfer ratio.[2]

(*From new wall chart, which also has a table of characteristics of* 56 *types of germanium alloyed junction transistors, General Transistor Corp.*, 91-27 138*th Place, Jamaica* 35, *N. Y.*)

For this literature circle **602** on inquiry card.

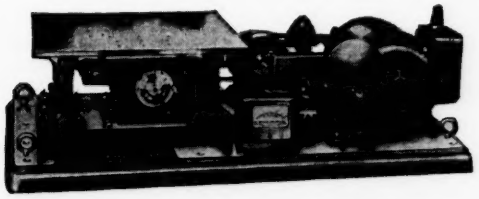
Magnet Wire Types and Trade Names

(*From new* 16-*page "Directory of Magnet Wire Types and Trade Names," Essex Wire Corp., Fort Wayne, Ind.*)

MANUFACTURERS	ENAMEL Class A pg 1	FORMVAR Class A pg 2	FORMVAR (self bonding) Class A pg 3	NYLON Class A pg 4	FORMVAR NYLON (combinations) Class A pg 5	SOLDERABLE Class A pg 6	ENAMEL Class B pg 7	SILICONE Class H pg 8	HERMETIC Class R pg 9	TEXTILES Class B–Class H pg 10
ACME WIRE COMPANY	Enamelite	Formvar	Formbond	Nylon	Nyvar	Polyvar	Isonel & Alkanvar			Cottonite, Silkenite, Nylon, Paperite, Daglas
AMERICAN STEEL & WIRE CO.		Amvar		Nylon	Amvar Nylon					
ANACONDA WIRE & CABLE	Plain Enamel	Formvar	Cement Coated Formvar	Nylon	Nyform	Analoc	Epoxy			Cotton, Vitrotex, Silotex, Paper
THE ELECTRIC AUTO LITE CO.	Plain or Black Enamel	Formvar	BondALite	Nylon	NyALite	SodALite	LectALite & IsALite	Glass Dacron	LectALite	Cotton, Paper
BELDEN MANUFACTURING CO.	Beldenamel	Formvar	Formbond	Nylon-Enamel	Nylclad	Beldol & Beldgrip	Alkanvar			Silkenamel, Nylitexenamel, Cotenamel, Paper, Cotton
ESSEX WIRE CORPORATION	Plain or Black Enamel	Formvar	Bondex	Nylon	Nyform	Sederex	Isonel; Thermalex	Silicone	Acrylex	Cotton, Fibre Glass, Paper, Dacron Glass

For this literature circle **603** on inquiry card.

Parts, Assemblies, Up to 150 lbs. Given Vibration Fatigue Test on the ALL AMERICAN Model 150 HLA-D



This machine, subjects parts or assemblies, up to 150 lbs. in weight, to a comprehensive vibration fatigue test. It has a 50% overload safety factor. Vibration in simple harmonic motion is produced horizontally. Displacement (double amplitude) is adjustable from 0" to .125". Automatic Range Selector controls acceleration and deceleration. From 10 cycles per second frequency may be increased uniformly to 60 c.p.s. and then decreased to 10 c.p.s. Any desired range within the total may be selected. Selector can be switched off and frequency held at any c.p.s.

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For more information circle **163** on inquiry card.

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- Does not depend on spring return or outside power sources.
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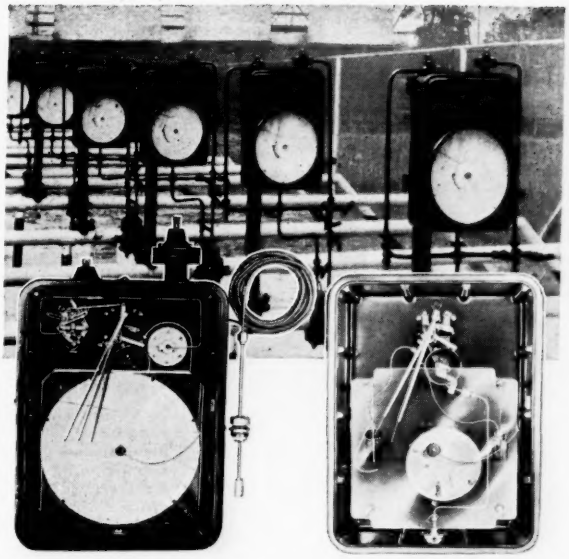

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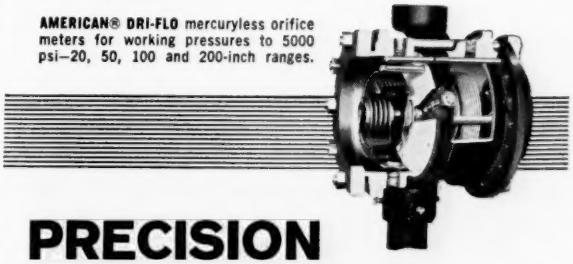
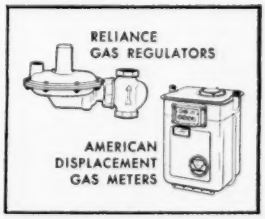


PRECISION MEASUREMENT

of flow, temperature, and pressure on one chart

Wherever precision measurement and economy of operation are required; at high or low flow rates, at varying temperatures, whether in recording, indicating, integrating or telemetering models, American orifice meters are synonymous with accurate, dependable, trouble-free service and low maintenance costs.



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GENERAL SALES OFFICE: Philadelphia 16, Pennsylvania • Albany Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago Dallas • Denver • Erie • Houston • Kansas City • Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle Tulsa • Wynnewood. IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Regina

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Check and calibrate any type of thermocouple-actuated temperature instrument with one portable Pyrotest

Read temperatures or millivolts directly . . . without graphs, charts or conversion tables

The only portable potentiometer pyrometer with interchangeable direct reading scales

Pyrotest is 9 instruments in one, with 6 standard scales for thermocouples; 3 standard scales for millivolt readings. Special scales for any desired reading or use. Scales interchangeable in 30 seconds. Compact, rugged, easy to carry—12 lbs.; 12" x 9" x 8½". Accurate to 1/6 of 1%. Self-contained power supply. Write for new bulletin 9B.

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For more information circle **167** on inquiry card.

Briefs—CONTINUED

Relative Humidity Table

The top line of numbers indicates the air temperature or dry bulb temperature. The column of numbers at the side indicate the difference in degrees between the wet and dry bulb thermometer readings. The numbers within the table indicate the percentage of relative humidity.

IRC RELATIVE HUMIDITY TABLE

DRY BULB TEMPERATURE (°F.)

DEPRESSION OF WET BULB (°F.)	132	136	140	144	148	152	156	160	164	168	172	176	180	184	188	192	196	200
1	97	97	97	97	97	98	98	98	98	98	98	98	98	98	98	98	98	98
2	94	94	95	95	95	95	95	95	95	95	95	96	96	96	96	96	96	96
3	92	92	92	92	92	93	93	93	93	93	93	94	94	94	94	94	94	94
4	89	89	89	90	90	90	90	90	91	91	92	92	92	92	92	92	92	92
5	86	86	87	87	87	87	88	88	88	89	89	89	89	90	90	90	90	90
6	84	84	84	84	85	85	85	85	86	86	87	87	87	87	87	88	88	88
7	81	81	82	82	82	83	83	83	84	84	85	85	85	85	85	86	86	86
8	79	79	79	80	80	81	81	81	82	82	83	83	83	83	83	84	84	84
9	76	77	77	78	78	79	79	79	80	80	81	81	81	81	82	82	82	82
10	74	74	75	75	76	76	77	77	78	78	79	79	79	79	80	80	80	80
11	71	72	73	73	73	74	74	75	75	76	76	77	77	77	78	78	78	79
12	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76	76	76	77
13	67	68	68	69	69	70	71	71	72	73	73	73	73	74	74	75	75	75
14	65	65	66	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74
15	63	63	64	64	64	66	66	67	67	68	69	69	70	70	71	71	72	72
16	61	61	62	63	64	64	65	65	66	67	67	68	68	69	69	70	70	70
17	58	59	60	61	61	62	63	63	64	65	65	66	66	67	67	68	69	69
18	56	57	58	59	60	60	61	61	62	63	63	64	64	65	66	67	67	67
19	55	55	56	57	58	59	59	60	60	61	62	63	63	64	64	65	66	66
20	53	54	54	55	56	57	57	58	58	59	60	61	61	62	63	63	64	64

For example: Dry bulb reading is 140. Wet bulb thermometer is depressed 10 degrees. The number under 140 and opposite 10 is 75, which indicates that there is 75 percent relative humidity . . . (*From new wall chart, International Radiant Corp., 4 Manhasset Ave., Port Washington, N. Y.*)

For this literature circle **604** on inquiry card.

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NEW 1957 SELF CONTAINED IMPROVED MODEL

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- ✓TILTING STAGE FOR HELIX, ANGLES AND BEVELS
- ✓4" DIA. STAGE OPENING
- ✓14" DIAMETER SCREEN
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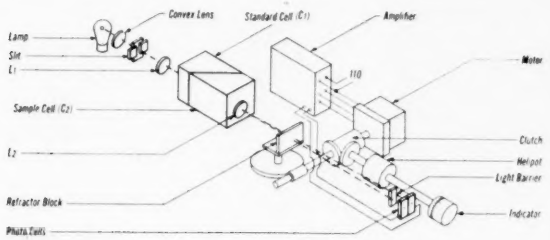
For more information circle **168** on inquiry card.

Process Refractometer

The process Refractometer measures the difference in refractive index between a liquid standard and a flowing liquid sample obtained directly from a process line. This measurement is made possible by the fact that a beam of



light is bent as it passes from one medium to another of different refractive index. Beam deflection is proportional to refractive index difference and is readly measured by the optical-servo system of the Process Refractometer.

Light from an incandescent lamp collimated by a slit-and-lens system traverses the liquid prism cells (C_1 and C_2) where the beam is bent in proportion to the refractive index. The beam is focused by lens L_2 and then redirected toward two photocells by a refractor block mounted on a turntable which is positioned by the servomotor. The beam is split into two parts by a light barrier just before reaching the photocells. At balance, the image of the slit is evenly divided so that each photocell receives an equal amount of light . . . (*From new 8-page Bulletin 1833, Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*)

For this literature circle **605** on inquiry card.

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Counts faster, yet accurately.

Records in printed form.

Automatically resets.

Three important reasons why the Ametron Recording Counter is in demand by leading industrial plants and scientific laboratories.

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MINI-SCOPE

Less than 8" square

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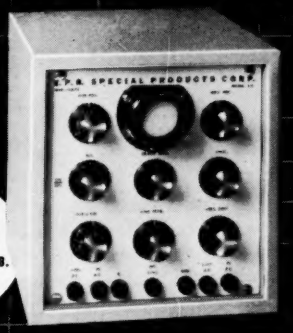

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For more information circle **170** on inquiry card.

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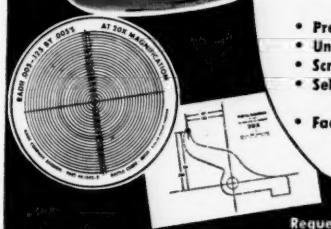

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For more information circle **171** on inquiry card.

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AGA DIVISION

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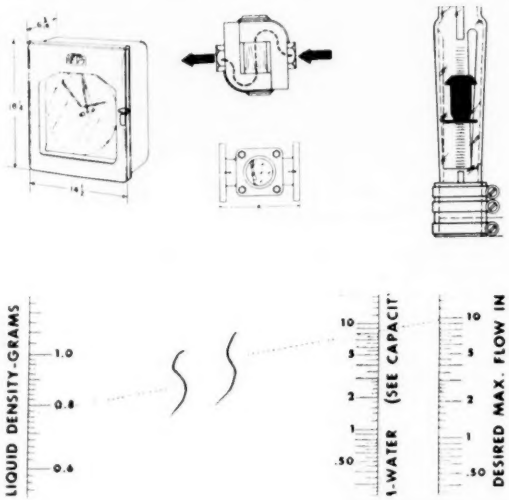
Pioneers in pneumatic timing.

For more information circle **172** on inquiry card.

Process Instrumentation

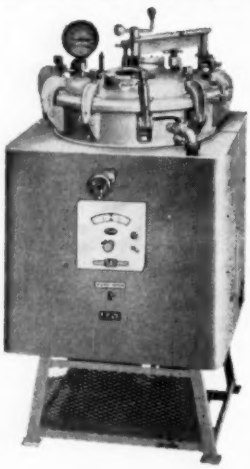
The F&P Flowrator meter is an example of customized instrumentation delivered off-the-shelf. Others include: Flow Test Kits, By-Pass Meters, All-Glass Flowrator Meters, Sight Flow Indicator, Specific Gravity Test-



ers, Purgerator Meters, Pneumatic Receivers, Pressure Instruments, Miniature Pneumatic Indicators, Chlorinators, etc. . . (*From new 30-page Catalog 2, including sizing nomographs, Fischer & Porter Co., Hatboro, Pa.*)

For this literature circle **606** on inquiry card.

AUTOMATIZE YOUR ENCAPSULATING



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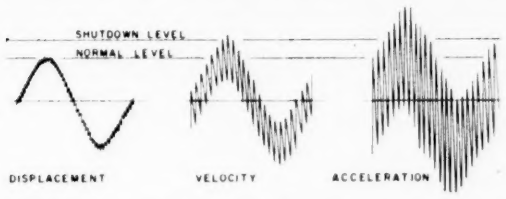
For more information circle **174** on inquiry card.

Vibration Detector

The "Vibraswitch" is a device which anticipates trouble in rotating or reciprocating machines by continuously monitoring vibration or roughness of operation. When the vibration level exceeds normal by a pre-adjusted amount the internal switch actuates, shutting down the protected equipment, or sounding an alarm. . . In some instances, the vibration is a low amplitude high frequency "noise"



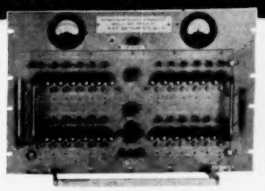
and is clearly audible for several seconds or minutes prior to complete failure. An example is the vibration produced by a failing bearing. The latter is initially an extremely small amplitude and would not be measurable with a displacement type vibrometer. The sensitivity of the Vibraswitch increases with frequency, making it equally suitable for sensing either increases in amplitude at the operating speed, or high frequency chatter, noise, or shock . . . Thus complete protection is obtained, which is not obtained in devices which measure only shaft eccentricity or respond only to substantial amplitude changes. This is illustrated in Figure 1, which shows the same condition of vibration in terms of displacement, velocity and acceleration . . . (*From new 4-page Bulletin 600-1, Robertshaw-Fulton Controls Co., Fielden Instrument Div., 2920 N. Fourth St., Phila. 33, Pa.*)

For this literature circle **607** on inquiry card.

new B & F Strain Gage Control Unit permits

DATA REDUCTION

FASTER . . . EASIER . . . MORE ACCURATELY



B & F Bridge-Balance and Calibrating Unit, Model 24-202, is a precision-built instrument for the balance, control and SERIES calibration of strain gages, accelerometers, pressure pickups and other resistive-type transducers.

Proving invaluable today in missile range instrumentation systems and flight test programs of advanced military aircraft, the Model 24-202 eliminates the need for "averaging through" calibration pulses or "fairing" zero and base line references.

FEATURES:

Independent adjustment for each channel of:

- VOLTAGE—(Individual Channel Control Switches)
- BALANCE
- GALVANOMETER DAMPING (SHUNT and SERIES)
- SENSITIVITY
- CALIBRATING LEVEL and PHASE

For complete details on this or other models with 6, 12 and 18 channels, write, wire or call.

B&F instruments, Inc.

4732 N. Broad Street
Philadelphia 41, Pa.
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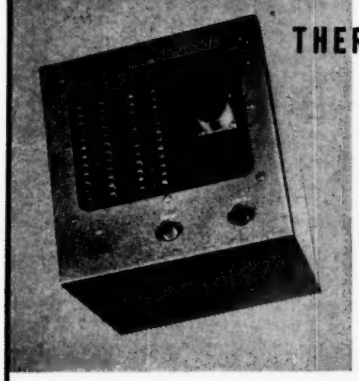
other products: Torque Meter Systems, Accelerometers

For more information circle **176** on inquiry card.

PACE

THERMOCOUPLE REFERENCE JUNCTION



RJ SERIES THERMOCOUPLE REFERENCE JUNCTIONS operate from 115 volt line to provide thermostatically controlled temperature reference for multi-channel thermocouple systems. Reference Junction permits use of copper lead wire without inconvenience of ice-bath maintenance, and eliminates necessity for cold-junction compensation.

Features . . .

Temperature stability within ½°F, and uniformity within 0.1°F.
Control temperature adjustable.
Multi-wire junctions available for thermocouple choice in each channel.
Variety of thermocouple types, number of channels and input-output connections offered in standard models.

PACE *engineering company*

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TURN TO PLUMMER AND KERSHAW FOR—

* Complete Optical Instruments made to Specifications.
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TIME YOUR TESTS IN SPLIT-SECONDS!

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ALL PURPOSE LABORATORY TIMERS

MODELS AT $23.95 TO $29.95

You can set the large 8" dial for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, **Electric Stop Clocks,** are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price $37.50

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Briefs—CONTINUED

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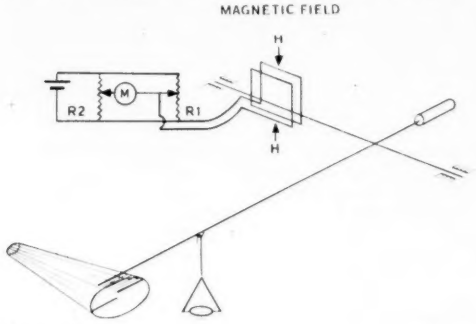
A novel application of physical principles has been combined with the most modern engineering design to create a radical advance in micro-weighing instrumentation . . . This balance is so rugged and immune to its environment that any part of your laboratory or office becomes the micro-balance room.

Current through the coil will apply a torque to the beam. Coil current is adjusted by means of R1 to make



Range of Sample Weight	Sensitivity	Accuracy
0-5 mg	1 microgram	2.5 micrograms
0-10 mg	2 micrograms	5.0 micrograms
0-20 mg	5 micrograms	12.0 micrograms
0-50 mg	8 micrograms	30.0 micrograms

the torque equal and opposite to that of the sample, as indicated by alinement of the beam and a fiduciary mark. Then coil voltage is measured accurately with precision potentiometer R2 and galvanometer M. Auxiliary circuits,

Standardize on Easy-to-Read

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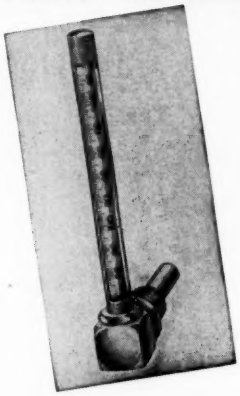
FLAT BORE **ENGRAVED STEM**

MIDGET INDUSTRIAL THERMOMETERS



★ **ACCURATE**—to within a fraction of a degree

★ **EASY - TO - READ**—broad — flat stripe — mercury column in a yellow stem

★ **ECONOMICAL**—replacement can be inserted on-the-job without difficulty

★ **ARMOUR PROTECTED**—to resist corrosion and dirt

★ **TWO TYPES**—angle and straight stem

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ACCURACY SCIENTIFIC INSTRUMENT CO.

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PHILADELPHIA 33, PA.

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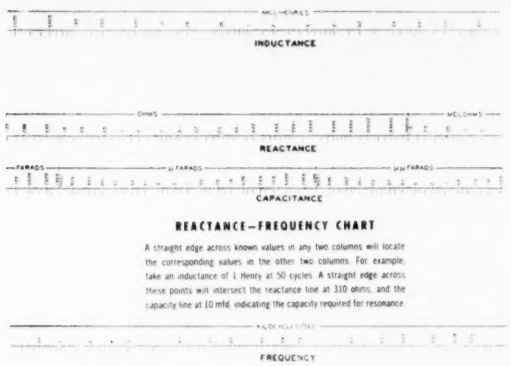
not shown, compensate for variations in pan weight, battery voltage, etc., calibrate multiturn dial on R2 to read directly in micrograms, and permit selection of various ranges.

Because the beam is always returned to the same position, torque is exactly proportional to current, in accordance with Ampere's Law. And, since the balance is calibrated with a known mass, measurements are in true mass units independent of the local force of gravity . . . (*From new 4-page bulletin, Cahn Instrument Co., 7712 Danvers St., Downey, Calif.*)

For this literature circle **608** on inquiry card.

Reactance-Frequency Chart


INDUCTANCE
REACTANCE
CAPACITANCE
REACTANCE—FREQUENCY CHART
A straight edge across known values in any two columns will locate the corresponding values in the other two columns. For example, take an inductance of 1 Henry at 50 cycles. A straight edge across these points will intersect the reactance line at 310 ohms, and the capacity line at 10 mfd, indicating the capacity required for resonance.
FREQUENCY

(*From new 36-page 1957-Catalog, United Transformer Co., which includes complete line of reactors, filters, magnetic amplifiers, etc., 150 Varick St., New York 13, N. Y.*)

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Small Motors

"Needed a dependable motor for accurate chart drive on Monitorecord."

Sheffield Corporation, Dayton, Ohio

The new "Monitorecord" by Sheffield Corporation, Dayton, Ohio, times and records simultaneous and sequential operational events of automatic machines and devices. Capable of monitoring up to 14 operations simultaneously, this instrument provides split-second recording with scribed lines on a strip chart. To accurately drive this chart, Sheffield Corporation selected the Barber-Colman DYAZ geared synchronous motor. For accurate actuation of your instruments, too, there is a wide selection of Barber-Colman motors up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed. Write for Catalog F-4271.

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When it's B/M "Matched Metering"

—you know it's accurate!

The high fidelity of Burgess-Manning Electric and Electronic Meters is made possible only by the Burgess-Manning null-balance inductance bridge, servo-powered meter principle employed. To this has been added the refinement of a calibrated cam, which matches the calibration of the recorder-totalizer and the differential producer for perfection thru "Matched Metering." Burgess - Manning electric transmission is suitable for distances up to 5000 feet. You'll never regret having specified Burgess-Manning "Matched Metering" for greatest overall accuracy.

Burgess-Manning Meters are also available in mechanical types.

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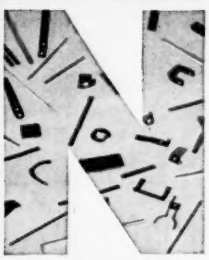
Instrumentation and Controls for water, steam, gases, sewage and industrial wastes

For more information circle **182** on inquiry card.

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



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Consult Ney's Engineering Dept. on any problem involving precious metals to improve your products.

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SIMPLE AUTOMATIC OPERATION . . . RUGGED & RELIABLE
MEAN FLOW OF GASES & LIQUIDS
TURBULENCE INTENSITY
ROTATING STALL
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CAVITATION IN LIQUIDS
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SYSTEMS TO 60,000 CPS ALSO AVAILABLE

CONSTANT TEMPERATURE
HOT WIRE ANEMOMETER SYSTEMS

FLAT RESPONSE—D.C. TO 1000 CPS.
LOW NOISE LEVEL
3 UNITS FIT INTO 19 INCH RACK

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315 NO. ABERDEEN STREET, CHICAGO 7, ILLINOIS
SALES REPRESENTATIVES THROUGHOUT THE UNITED STATES AND CANADA

ISA SHOW—BOOTH 203
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MARSH *Mastergauge*

The gauge that has everything!

- **LEAK-PROOF ONE-PIECE CONSTRUCTION** . . . bourdon tube fused to socket and tip by exclusive "Conoweld" process.
- **STURDY "MARSHALLOY" CASE** . . . formed of boiler-plate-thickness steel, copper clad inside and outside to give it the corrosion resistance of solid copper. It's one third lighter, but four times stronger than cast iron.
- **PRECISION "MASTERGAUGE" MOVEMENT** . . . with such exclusive features as the coined sector gear.
- **AVAILABLE WITH STAINLESS TUBE AND SOCKET** . . . choice of stainless steels and alloys for all corrosive conditions.
- **WITH "RECALIBRATOR"** . . . quickest and best way to keep a gauge accurate.

These features are combined only in "Mastergauge", standard bearer for the broad line of Marsh Gauges . . . each the best of its kind. Ask for data.

MARSH "THE STANDARD OF ACCURACY"

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Marsh Instrument and Valve Co. (Canada) Ltd. 8407 103rd St., Edmonton, Alberta.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas.

For more information circle **185** on inquiry card.

Briefs—CONTINUED

Miniature Bearings

The load capacity for RMB miniature ball and roller bearings is obtained from the following formula:

$$P = \frac{C}{f \times s}$$

P—load in pounds, C—load factor for a given bearing, f—speed factor, and s—life factor.

speed factor f

rpm	1	100	200	500	1000	2000	3000	5000
f	0.7	1.9	2.3	3.2	4	5.2	5.8	6.9
rpm	10000	15000	20000	30000	40000	50000	75000	100000
f	8.7	10	11	12.5	13.8	15	17	18.8

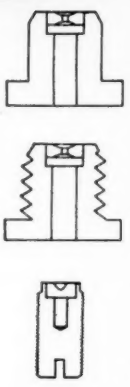
life factor s

life in hours	1000	1500	2000	3000	4000	5000	7500	10000	20000
s	1.3	1.4	1.6	1.8	2	2.2	2.4	2.7	3.4

When calculating the load capacity of a ball bearing, the static and dynamic stresses must be taken into consideration. When a ball bearing is subjected to both radial and axial stresses, these must be added to obtain the true value of P. The values shown for f, s and C are valid in all cases where the outer ball races are fixed and the shafts or inner races revolve. If the outer races are revolving, the value C must be reduced by 25%. . . . (*From new 16-page bulletin, Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.*)

For this literature circle **610** on inquiry card.

PRECISION JEWEL BEARING ASSEMBLIES . . .



for AIRCRAFT • ELECTRICAL MECHANICAL and MARINE INSTRUMENTS

Sapphires set in brass, or other metal assemblies made in any quantity to close tolerance specifications are produced by Moser Jewel Company—*manufacturers of industrial jewels for over 50 years.*

Moser also provides highly polished pivots, staffs —silicon and spring loaded assemblies for high shock resistance.

SEND SPECIFICATIONS — DETAILED INFORMATION READILY GIVEN.

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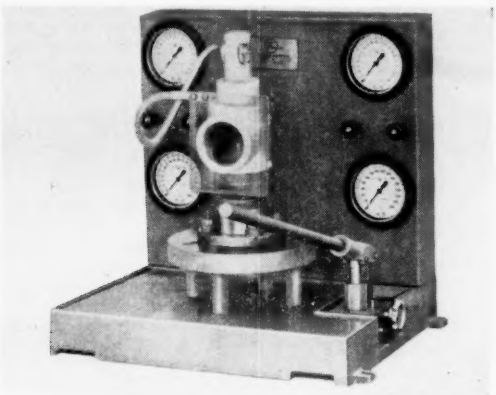
P.O. Box 150 • Perth Amboy, N. J.
"Manufacturers of all types of Industrial Jewels"

For more information circle **186** on inquiry card.

Hydraulic-pneumatic Portable Test Stand

The new Farris Utility Porta-Tester . . . a completely portable unit weighs only 55 pounds and can be carried about like an overnight case. (Over-all dimensions: 18"

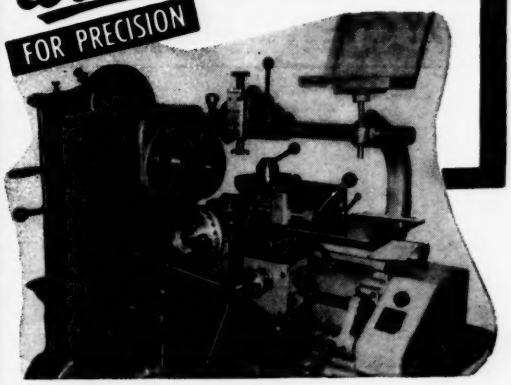


x 14" x 8"). Hydrostatic testing is the answer to inaccurate gauges and improvised test set-ups . . . Use it for testing valves, pressure vessels, piping, steam generators, etc., at the job site to 3000 psi . . . You stock a small supply of springs to make your spring setting changes up to 3000 psi . . . Suitable for use with water or hydraulic fluid. (*From catalog FE 147, Farris Engineering Corp., 400 Commercial Ave., Palisades Park, N. J.*)

For more information circle **611** on inquiry card.

OUTSTANDING VALUE

Weisser CHUCKING LATHE FOR PRECISION



FEATURES

• Comes with round turret or octagonal tool plate that can be removed and saves retooling • Spindle and collet capacity of 1-9/16" and 3" • Thread chaser accommodates two threads of different pitches • 5½" H.P. motor • Automatic indexing of turret • Power feed to turret • Preloaded precision roller bearings • Guaranteed accuracy .0005", actually holds closer tolerances • Prominent users • Attractively priced, quick deliveries. *Write for catalog and prices.*

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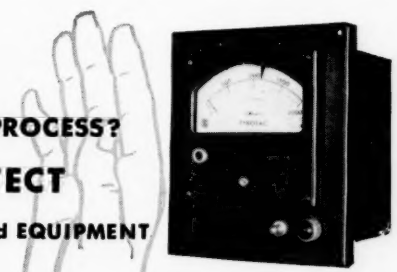

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Automatically

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Not expensive...but a simple, automatic way to safeguard your investment in heating equipment and materials in process.

The precision-built Pyrotac constantly indicates temperature of the heated equipment and sounds an alarm and/or shuts down the equipment at a safe, preset temperature. May also be used as a controller on processes where shutdown is required upon reaching final process temperature—such as ceramic kilns, molds, etc. Automatic thermocouple break protection assures complete safety if couple or lead wire should break.

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Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

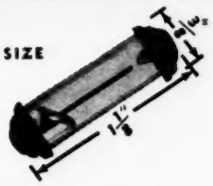
For more information circle **187** on inquiry card.

NEW LOW COST

MERCURY SWITCH

MINIATURE TYPE

ACTUAL SIZE



HERMETICALLY SEALED

Introducing a new Mercoid hermetically sealed mercury switch—a tilting type switch designed to be installed in the same manner as a cartridge fuse (spring clips or holders can also be used for mounting purposes).

Operation is noiseless and contact position is readily visible.

Its small size and light weight make it particularly adaptable for such applications as business machines, coin operated machines, signals, sign flashers or refrigerator doors.

Electrical rating: SP-ST: 1.75 amp. 115 volts; 0.6 amp. 230 volts.

WRITE FOR BULLETIN 665

THE MERCOID CORPORATION

4209 Belmont Ave., Chicago 41, Ill.

For more information circle **189** on inquiry card.

INSTRUMENTS and AUTOMATION — New Literature

AUTOMATION

PNEUMATIC CONTROLLERS and their theory are described in new 44-page Bulletin A130.—The Bristol Company, Waterbury 20, Conn.
Circle **612** on inquiry card.

CONTROL AND INSTRUMENTATION at the Albany Steam Station is described in new 12-page Bulletin MSL-3.—Hagan Chemicals & Controls, Inc., Pittsburgh 30, Pa.
Circle **613** on inquiry card.

CONTROL SYSTEM for grinding mill, controlling mill load at optimum operating point, is described in 2-page Folder ND-600(1).—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.
Circle **614** on inquiry card.

SYSTEMS manufacture and applications are the subject of new 8-page brochure.Thomas A. Edison Instrument Div., West Orange, N. J.
Circle **615** on inquiry card.

STATIC SWITCHING SYSTEMS for dependable control on normal contact making devices are described in new 8-page Bulletin GEA-6364A.—General Electric Co., Schenectady 5, N. Y.
Circle **616** on inquiry card.

PNEUMATIC DRIVE UNITS for remote operation and positioning of valves, dampers, louvers, rheostats, vanes and variable-speed drives are described in new 4-page Bulletin 1033.—Copes-Vulcan Div., Blaw-Knox Co., Erie 4, Pa.
Circle **617** on inquiry card.

VALVES

AUTOMATIC VALVES for plumbing and heating are described in new 12-page Catalog P&H-57.—A. W. Cash Valve Mfg. Corp., 666 E. Wabash Ave., Decatur, Ill.
Circle **618** on inquiry card.

AUTOMATIC ENGINE STOP VALVE which automatically shuts down turbine, compressor, or engine in event of over-speed or runaway is described in a new 8-page Bulletin S-3A.—Golden Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.
Circle **619** on inquiry card.

PRESSURE REGULATORS with interchangeable pilot and valve body types are featured in new 4-page Brochure No. 1011—Spence Engrg. Co., Inc., Walden, N. Y.
Circle **620** on inquiry card.

VALVES, driers, strainers and accessories for refrigeration, air conditioning and industrial applications are described and illustrated in new 16-page Catalog 102.—Henry Valve Co., 3215 N. Ave., Melrose Park, Ill.
Circle **621** on inquiry card.

RELIEF AND BACK PRESSURE VALVE designed to function on both condensing and non-condensing systems is described in 2-page catalog sheet Section III.—Atlas Valve Co., 280 S. St., Newark 5, N. J.
Circle **622** on inquiry card.

CONTROL VALVES, direct acting, reverse acting, threeway, are illustrated in new 4-page Bulletin V-8.—Seeley Instrument Co., Inc., Niagara Falls, N. Y.
Circle **623** on inquiry card.

CHECK VALVES, relief valves, and shut-off valves of small size are illustrated in new 4-page brochure.—James, Pond & Clark, Inc., 2181 E. Foothill Blvd., Pasadena 8, Calif.
Circle **624** on inquiry card.

TEMPERATURE

HOT BOX DETECTOR "Servosafe," highly sensitive to abnormal heat from freight car journal boxes, is described in new 4-page brochure.—Servo Corp. of America, 2020 Jericho Tpke., New Hyde Park, N. Y.
Circle **625** on inquiry card.

THERMOMETERS, THERMOSTATS, HYDROMETERS, ETC. are described in new 22-page Catalog 57.—Nurnberg Thermometer Co., Inc., 124-126 Livingston St., Brooklyn 1, N. Y.
Circle **626** on inquiry card.

BI-METAL THERMOMETERS in 3" and 4½" sizes, dust, moisture, and fume-proof, are illustrated and specified in new 12-page Catalog 225 C.—Moeller Instrument Co., Richmond Hill 18, N. Y.
Circle **627** on inquiry card.

THERMOCOUPLES, magnesium oxide insulated, are described in new 2-page Bulletin 35-700.—Clarke H. Joy Co., 27005 Knickerbocker Rd., Bay Village, Ohio.
Circle **628** on inquiry card.

NEW MULTI-PURPOSE DIGITIZER
for precision voltage measurement

Franklin Model 310A Digitizer

COSTS only $1975.00 F.O.B.

provides fast, accurate readings

In the laboratory or on the production line, this all electronic, multipurpose digitizer is ideal for use as an analog to digital converter, voltmeter or data reduction element. Measuring voltages from 000.0-120.0 volts DC, it provides accuracy of 0.1% of full scale and speed of 60 readings per second, automatically or on command . . . heretofore unobtainable at this low cost. Coded outputs of each significant figure in the visual readout provide a signal source to operate matrices, printers, punches, or categorizing equipment.

Also available—special DC amplifiers which convert very low voltages (microvolt ranges) to levels useable by the Model 310A Digitizer.

FEI

Franklin Electronics, Inc.
BRIDGEPORT, PA.
Electronic & Nuclear Development & Manufacturing

For more information circle **190** on inquiry card.

TEMPERATURE CONTROL EQUIPMENT. New 4-page Process Data Sheet 660(1) describes temperature control equipment for growing germanium and silicon crystals.—Leeds and Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **629** on inquiry card.

THERMOCOUPLES. Complete line of elements, assemblies, components, accessories and instruments are described in new 24-page catalog.—Instrument Service Engineering Labs., 1205 Lamar St., Dayton 4, Ohio.

Circle **630** on inquiry card.

GAS THERMOSTAT Model DG in temperature ranges up to 700°F is described in new 4-page Bulletin RT-813.—Robertshaw-Fulton Controls Co., 110 E. Otterman St., Greensburg, Pa.

Circle **631** on inquiry card.

THERMOSTATS for precise temperature control are described in new 4-page Bulletin 8400. Includes temperature conversion charts.—Stevens Mfg. Co., Inc., 45 N. Plymouth St., Lexington, Ohio.

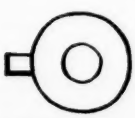
Circle **632** on inquiry card.

THERMOSTATIC STEAM TRAPS for outdoor and non-freeze service are described in new 4-page Bulletin 257. —The V. D. Anderson Co., 1935 W. 96th St., Cleveland 2, Ohio.

Circle **633** on inquiry card.

DIAL THERMOMETER "Adjust-Angle" is described in Bulletin No. AAD-57. —Weksler Thermometer Corp., 195 East Merrick Road, Freeport, L. I., N. Y.

Circle **634** on inquiry card.



FLOW

FLOW METERS. Ring balance recorders, indicators and controllers are described and illustrated in new 6-page Bulletin MSP-141.—Hagan Chemicals & Controls, Inc., 323 Fourth Ave., Pittsburgh 30, Pa.

Circle **635** on inquiry card.

FLOW MEASUREMENT for water works using Parshall flume, with application of d/p cell transmitter is described in new 2-page Application Data Sheet 831-35.—The Foxboro Co., Foxboro, Mass.

Circle **636** on inquiry card.

FABRICATED VENTURI TUBES. Available with flanges, plain or beveled ends, are the subject of 2-page Bulletin 35.—Vector Manufacturing Co., Inc., Jenkintown, Pa.

Circle **637** on inquiry card.

POSITIVE DISPLACEMENT PUMP. Maker's "Sigmamotor," Type T-8, which forces liquids, gasses and slurries through tubing, is detailed in new 2-page bulletin.—Sigmamotor, Inc., 3 N. Main St., Middleport, N. Y.

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NOW...TUBELESS RELIABILITY WITH 30-MILLISECOND RESPONSE!

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Here is extremely reliable and accurate control for 60-cycle machine tools and processes. With response speed of less than 30 ms, these compact, all-magnetic units react instantly to paper-tape programmed input, and deliver high-gain, highly linear output over a wide temperature range. They eliminate need for bulky, slow-acting rotating-type or hydraulic devices.

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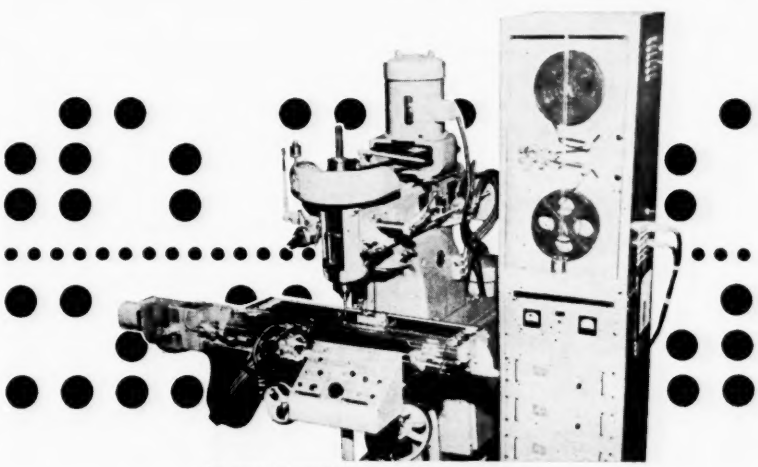

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NEW LITERATURE

POSITIVE DISPLACEMENT METER to measure acids, alkalis, and other liquids is described in new 4-page Bulletin No. 94/10.—Neptune Meter Co., 19 W. 50th St., New York 20, N. Y.
Circle **639** on inquiry card.

CONTROLLED VOLUME PUMPS in petroleum refining are described in new 16-page Bulletin 457.—Simplex and duplex models are subject of new 4-page Bulletin 557.—The complete line of motor driven pumps is contained in new 32-page Bulletin 553-1. —Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.
Circle **640** on inquiry card.

PRESSURE

ELECTROMANOMETER for precision pressure-measuring for laboratory, field or automatic process control is described in new Bulletin 1547 A.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **641** on inquiry card.

PRESSURE INDICATORS. New "smallcase," Series 1450 instrument line for indicating, transmitting and controlling pressure and temperature is described and illustrated in new Catalog 51-1450.—Fischer & Porter Co., 212 Jacksonville Rd., Hatboro, Pa.
Circle **642** on inquiry card.

SPECIAL TUBING for Bourdon pressure gages is described in 4-page article reprint.—Superior Tube Co., 1566 Germantown Ave., Norristown, Pa.
Circle **643** on inquiry card.

PRESSURE TESTING. New technical file on pressure testing air-, gas-, and liquid-tight vessels or assemblies, containing 16 data sheets and 2 catalogs, is now available.—Mechanical Products Corp., 168 N. Ogden Ave., Chicago 7, Ill.
Circle **644** on inquiry card.

FORCE, WEIGHT

CONVEYOFLO METER continuously weighs and controls belt-conveyed materials described in new 4-page Bulletin 550-P5.—Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.
Circle **645** on inquiry card.

SCALES with "Shadograph" indication that eliminates parallax error are offered in new 8-page Brochure 3333.—The Exact Weight Scale Co., 944 W. Fifth Ave., Columbus, Ohio.
Circle **646** on inquiry card.

AUTOMATIC BAGGING SCALES are described in maker's new 6-page Bulletin 0357.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.
Circle **647** on inquiry card.

WEIGHING, "The A-B-C's of Accuracy in Weighing and Force Measurement Systems," a 12-page brochure, explains proving rings and their use. —Morehouse Machine Co., 233 W. Market St., York, Pa.

Circle **648** on inquiry card.

BASIS WEIGHT and moisture control systems for the paper industry are described in new Bulletin 19.—Isotope Products, 1711 Elmwood Ave., Buffalo 7, N. Y.

Circle **649** on inquiry card.

ACCELERATION, SPEED, TIME

LINEAR ACCELEROMETER are illustrated and described in new 2-page Bulletin LF-MF-6-57.—B & F Instruments, Inc., 4732 N. Broad St., Phila. 41, Pa.

Circle **650** on inquiry card.

TACHOSCOPES, instruments for precise speed and linear measurements, are the subject of two new releases. Bulletin 35-40 describes "Jagabi" hand tachoscope; Bulletin 35-40a covers tachoscope with 1:10 ratio gear box. —James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

Circle **651** on inquiry card.

ELECTRIC TIME CONTROLS, from general purpose manual-set interval timers to instruments designed for use in specific applications, are subject of new 4-page "Condensed Time Control Catalog".—Miller-Harris Instrument Co., 601 E. Ogden Ave., Milwaukee 2, Wis.

Circle **652** on inquiry card.

VELOMETERS providing instant, direct reading of suction and supply air velocities are described in new 8-page Bulletin 2448.—Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago 10, Ill.

Circle **653** on inquiry card.

INDUSTRIAL TACHOMETERS, generators, indicators, and recorders are described in new 12-page Catalog GEC-1258A.—General Electric Co., Schenectady 5, N. Y.

Circle **654** on inquiry card.

SPEED REDUCER. New pocket size, 8-page folder describes Bantam Speed reducers as applied in apparatus used for "growing" single germanium crystals.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Circle **655** on inquiry card.

SPEED REDUCERS. Available in 8 and 10 speed models, are subject of new 2-page Bulletin 262.—Insco Co., Hollis St., Groton, Mass.

Circle **656** on inquiry card.

STROBOSCOPE with high intensity daylight lamp for speed measurements and motion studies is covered in new 4-page Bulletin 162.—Slaughter Co., Piqua, Ohio.

Circle **657** on inquiry card.

ELECTRIC TIMING MOTORS. Timing devices and clock movements are contained in new 30-page Catalog 571.—Haydon Mfg. Co., Inc., Torrington, Conn.

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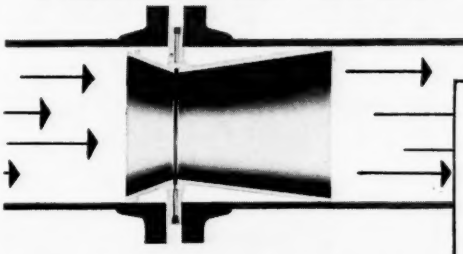
NEW TYPE FLOW METER **CUTS PRESSURE LOSS BY 93.5%***



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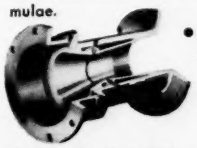

CAST DALL FLOW TUBE RECOMMENDED FOR WATER WORKS AND SEWAGE INSTALLATIONS

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DIVISION OF
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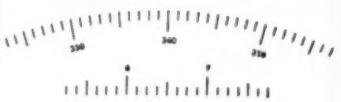

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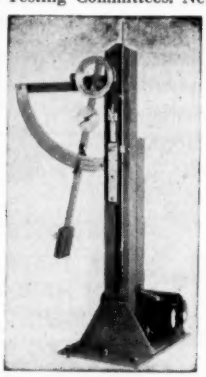

improved features are included, which simplify operation and insure an extremely high degree of accuracy. Suitable for materials such as papers, twine, wire, plastics, aluminum foil, tapes, etc. Many models in capacities from 25 lbs. to 1500 lbs. available.

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NEW LITERATURE

TIMING DEVICES. Interval timers, timing motors, repeat cycle timers, custom designed timers, elapsed time indicators, time delay relays, intervalometers, and stop clocks, are covered in new 50-page Catalog 3105710.—The A. W. Haydon Co., Waterbury, Conn.

Circle **659** on inquiry card.

TIME RECORDER, model SR plus totalizer, is outlined in new 4-page Catalog RT191-600.—Standard Instrument Corp., 657 Broadway, N. Y. 12, N. Y.

Circle **660** on inquiry card.

NOISE, VIBRATION

VIBRATION METER, for determining velocity, displacement and frequency, is described in new 4-page Bulletin 1538C. Also price list of vibration meters and associated equipment.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **661** on inquiry card.

NOISE MEASUREMENT. Theoretical as well as practical evaluation of residual noise in chopper circuitry is discussed in new 4-page technical paper "Measurement of Residual Noise in Chopper Circuitry".—James Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill.

Circle **662** on inquiry card.

INDUSTRIAL NOISE, its effect and recommended cures are evaluated in illustrated book "Why Must This Be?".—Sigma Engrg. Co., 1491 N. Vine St., Hollywood 28, Calif.

Circle **663** on inquiry card.

FILTERS

AUTOMATIC FILTERS. Maker's Figs. 822 and 823, automatic self-cleaning filters, are described in new 4-page bulletin.—Bowser Inc., Fort Wayne, Ind.

Circle **664** on inquiry card.

IMPERVIOUS GRAPHITE ENTRAINMENT SEPARATOR is described in new 4-page Catalog S-6900.—National Carbon Co., 30 E. 42nd St., New York 17, N. Y.

Circle **665** on inquiry card.

ANALYTICAL, LABORATORY

INFRARED ANALYZER "Lira" Model 200 is described in 2-page leaflet.—Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa.

Circle **666** on inquiry card.

ADSORBENTS. Price list of maker's complete line of partitioning agents and solid adsorbents for chromatographic analysis is the subject of new 4-page Bulletin 835.—Burrell Corp., 2223 5th Ave., Pittsburgh 19, Pa.

Circle **667** on inquiry card.

STAINLESS STEEL VACUUM-DRUMS for preservation and decontamination are described in new Bulletin 2272.—American Instrument Co., Inc., Silver Spring, Md.

Circle **668** on inquiry card.

LABORATORY BALANCE WEIGHTS. Weight classifications with tolerance for each and selection of balance weights by class are described in Lab-Guide No. 1.—Will Corp., Rochester 3, N. Y.

Circle **669** on inquiry card.

LABORATORY OVENS, humidity cabinets and water baths, particularly for materials testing laboratories, are presented in 4-page Bulletin 6-57.—Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.

Circle **670** on inquiry card.

FLUID DISPENSER. New 2-page leaflet describes the Corinth Finger-Tip Fluid Dispenser.—Palo Laboratory Supplies Inc., 81 Reade St., New York 7, N. Y.

Circle **671** on inquiry card.

BALANCES. New 2-page leaflet describes various models of makers line of triple beam balances.—Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J.

Circle **672** on inquiry card.

LABORATORY EQUIPMENT. Everything from petri dishes to the Beckman DK-2 spectrophotometer are contained in new 16-page Catalog 29.—Scientific Glass Apparatus Co., Inc., Bloomfield, N.J.

Circle **673** on inquiry card.

LABORATORY EQUIPMENT. Dial-speed stirrer, precision speed balance, demineralizers, ovens and portable refrigeration systems are among the items covered in new 16-page Bulletin 571.—A Daigger & Co., Kinzie at Wells, Chicago 10, Ill.

Circle **674** on inquiry card.

LABORATORY EQUIPMENT. New additions to maker's line of pH meters, chromatographic equipment, freeze-drying units, etc., are contained in new 16-page catalog.—Schaar and Co., 7300 W. Montrose Ave., Chicago 34, Ill.

Circle **675** on inquiry card.

TV ULTRAVIOLET MICROSCOPE, electronic color translating instrument with automatic microspectrophotometer is described in new 5-page Bulletin 101.—Neutronics Research Co., 165 Lake St., Waltham, Mass.

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LABORATORYWARE made from polyethylene is described and priced in new 20-page catalog.—Harshaw Scientific, Cleveland 6, Ohio.

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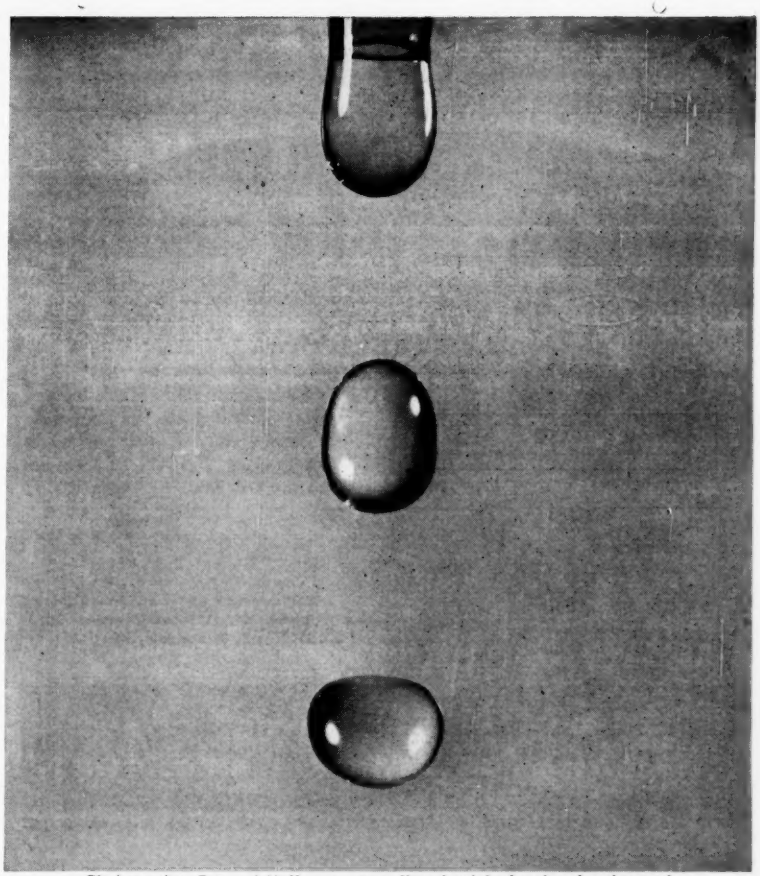

Photographer Bernard Hoffman uses a tiny droplet of water, forming and falling, to illustrate time sequence.

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Even in simple hydrodynamic situations like the one pictured above, time sequence is measured in micro-seconds. More often than not, other factors – such as pressure, volume and flow – all tend to complicate fluid time control. That's where the engineering leadership of S. Morgan Smith can help you most.

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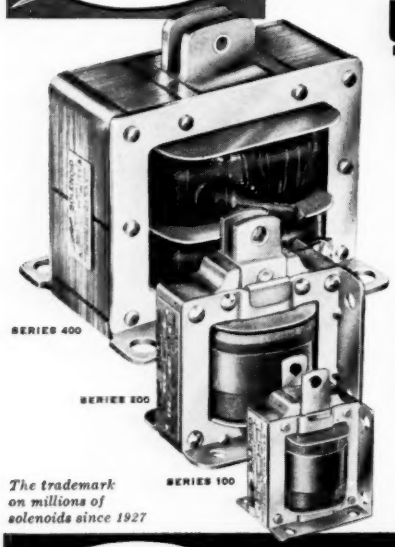

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NEW LITERATURE

ELECTRONIC FLUOROSCOPY in metal examinations applied with modern techniques is described in new 6-page folder.—Philips Electronics, Inc., Instruments Div., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **678** on inquiry card.

MELTING-POINT TESTER. German-made, is subject of new 4-page brochure.—Epic, Inc. (distributors), 154 Nassau St., New York 38, N. Y.

Circle **679** on inquiry card.

VISCOSIMETER maker's "Viscorator," which continuously measures and records temperature and temperature-compensated viscosity of liquids flowing in process piping, is described in 4-page Catalog 15A100.—Fischer & Porter Co., 76 Jacksonville Rd., Hatboro, Pa.

Circle **680** on inquiry card.

NUCLEONICS

AIR PARTICLE MONITOR. Model 900-2 for continuously monitoring and recording beta and gamma levels is described in new 2-page Bulletin 3004-7. Logarithmic count rate meter Model 727 for use with radiation detectors is subject of 2-page Bulletin 3002-7.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle **681** on inquiry card.

NUCLEAR PURIFIER. Model XP 15, including specifications, is subject of new 2-page Bulletin 4354-3-57.—The Permutit Co., 330 W. 42nd St., New York, N. Y.

Circle **682** on inquiry card.

COUNTING RATE METER. Model 511 modified Oak Ridge Q1511, is completely described and illustrated in new 2-page leaflet.—Radiation Instrument Development Lab., 5737 South Halsted St., Chicago 21, Ill.

Circle **683** on inquiry card.

OPTICAL

OPTICAL INSTRUMENTS. Telescopes, quality control tools, binoculars, microscopes, photographic items, accessories, and army surplus instruments are covered in new 68-page Catalog 575.—Edmund Scientific Co., Barrington, N. J.

Circle **684** on inquiry card.

CAMERAS. lenses, viewfinders are described in new 36-page catalog titled "Exakta Unlimited."—Exacta Camera Co., 705 Bronx River Rd., Bronxville 8, N. Y.

Circle **685** on inquiry card.

DATA, HANDLING

HIGH SPEED TYPER, an electronically operated printer is described in new 4-page bulletin. Digital tape reader for handling metallic Univac tape or equivalent plastic tape is subject of 2-page catalog.—Shepard Laboratories, Broad St. & Park Ave., Summit, N. J.

Circle **686** on inquiry card.

TAPE RECORDING SYSTEM. Specifications and performance characteristics of Series 3000 "Recordata" multichannel magnetic tape recorder appear in new Bulletin 5041.1.—American Electronics Inc. Recordata Div., 9449 W. Jefferson Blvd., Culver City, Calif.

Circle **687** on inquiry card.

CONVERSION TABLES. Handy, pocket size 6-page folder of tables simplifying conversion from decimal to binary numbers, or vice versa.—Barnes Engrg. Co., 30 Commerce Road, Stamford, Conn.

Circle **688** on inquiry card.

COMPARATOR using precision lead screws and decimal digitizers is described in new Bulletin CR-190.—Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles, Calif.

Circle **689** on inquiry card.

CALCULATING MACHINE. Imported "Produx-Multator" which features carrying back action, is described in new 2-page release.—Silver Bells Ltd. (distributor), 600 16th St., Oakland, Calif.

Circle **690** on inquiry card.

RECORDERS

OXYGEN RECORDERS, magnetic type, are described in new 4-page Process Data Sheet 705(1).Leeds & Northrup Co., Stenton Ave., Phila. 44, Pa.

Circle **691** on inquiry card.

RECORDERS, indicators and controllers for pressure, flow, temperature, level and are described in new 12-page Catalog 57-687-297.—The Hays Corp., Michigan City, Ind.

Circle **692** on inquiry card.

TESTING, INSPECTION

HARDNESS TESTERS, portable, to test hardness of any size, shape, and type metal, etc. is described in new four page bulletin.—Newage Industries Inc., 222 York Road, Jenkintown, Pa.

Circle **693** on inquiry card.

ADHESION TESTER, 2-page leaflet describes makers "Ply Adhesion Tester," and "Impact Fatigue Tester" used to predict the performance of packaging materials.—Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Phila. 44, Pa.

Circle **694** on inquiry card.

LEAK DETECTOR. Operating principles, methods of leak detection, specifications, maintenance, and optional equipment, are subject of new 12-page Brochure GEC-336B.—General Electric Co., Schenectady 5, N. Y.

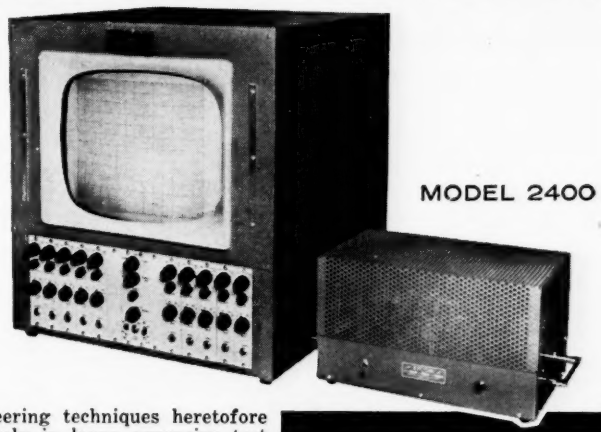
Circle **695** on inquiry card.

X-RAY EQUIPMENT, portable, for radiographic inspection, is illustrated and described in new 4-page folder.—Mitchell Radiation Products Corp., 128 Washington St., Norristown, Pa.

Circle **696** on inquiry card.

RYCOM INSTRUMENTS

12 Channel Multi-Trace Large Screen Oscilloscope



MODEL 2400

Engineering techniques heretofore used only in large expensive test equipment have been incorporated into this new Model 2400 large screen oscilloscope which displays 12 complex wave-forms simultaneously. This instrument is currently being used in the following applications: Telemetering, Stress and Strain, Vibration, Analog Computors, Medical Wave-forms and Production Testing of Multiple Circuits of Complex Studies.

SENSITIVITY: 10 mv/inch deflection.

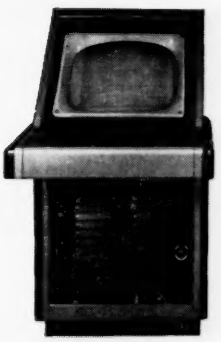
INPUT: Push-Pull direct coupled circuits for each channel.

FREQUENCY RESPONSE: dc to *2500 cps.

*This is displayed as 10 dot resolution, higher frequency is attained with less dot resolution, i.e. 10 kc is 2 dots, to form a sine wave.

SWEEP: 3 millimeter/second to 30 millimeters/millisecond.

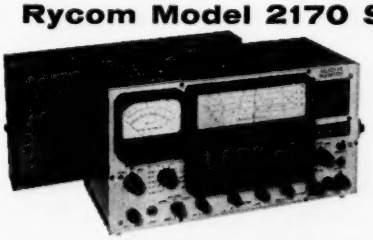
PARTIAL LIST OF USERS: General Motors Corp. • General Electric Co. • Glenn L. Martin Co. • Lockheed Aircraft • Weltronics Company • Baylor University • University of California • University of Washington.



MODEL 2400 RM

(Basically same as Model 2400 except with Modified Time Base)

Rycom Model 2170 Selective Voltmeter



FREQUENCY: 1 kc to 200 kc

LEVEL: −70 dbm to +32 dbm (full scale)

ACCURACY: ±.5 db from −80 dbm to +32 dbm; 1 kc to 200 kc

SELECTIVITY: 6 db down at 75 cps off; 60 db down at 355 cps off

SPURIOUS RESPONSES: below 60 db

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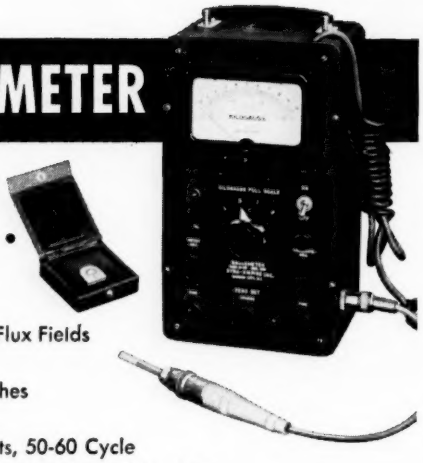
For more information circle **203** on inquiry card.

D-79 GAUSSMETER



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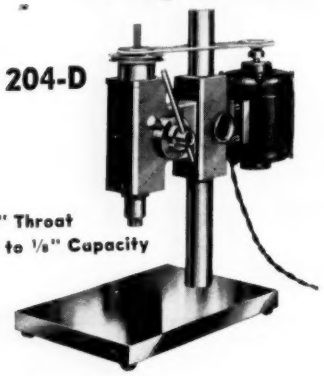

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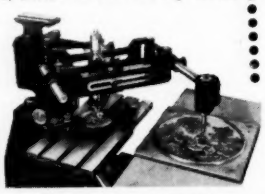

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NEW LITERATURE

X-RAY UNIT. Industrial x-ray unit, Baltospot 200, described in new 2-page leaflet, is designed for operations with thin magnesium up to three inches of steel; features simplicity, versatility, and reliability.—Balteau Electric Corp., New and Meadow Streets, Stamford, Conn.

Circle **697** on inquiry card.

CONVERSION CHART. A new release is a desk-size chart containing conversion data for Rockwell tests and other hardness scales, as well as tables for cylindrical corrections.—Torsion Balance Co., Clifton, N. J.

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ENVIRONMENTAL CABINETS, featuring "Power-O-Matic" control system and constant-flow mechanical refrigeration for accurate temperatures from 0°C to 180°C, are described in new 2-page Bulletin 5690.—Blue M Electric Co., Blue Island, Ill.

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OPTICAL TEST BENCH Model L.W. is described and illustrated in new 6-page brochure.—New interferometer is subject of new 8-page catalog.—Ball-point sperometers are specified in new 4-page folder.—Penn Optical & Instrument Co., 19642 Bristol St., P. O. Box 68, Costa Mesa, Calif.

Circle **700** on inquiry card.

TUBING, FITTINGS

TUBE FITTINGS. Tube and hose fittings are illustrated, and tube fitting size table included, in new wall chart.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **701** on inquiry card.

HYDRAULIC TUBING. Advantages of tubing for hydraulic lines, tubing materials and manufacture, is the subject of new 4-page reprint.—Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.

Circle **702** on inquiry card.

FLARING TOOL of one piece construction covering wide range of sizes is described in new 2-page Bulletin 3062-A.—The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

Circle **703** on inquiry card.

METAL HOSE including recommended pressures, temperatures and specific uses is the subject of new 12-page Catalog ID-100A.—Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill.

Circle **704** on inquiry card.

INDUSTRIAL TEFLON HOSE 2802 is described in new 4-page Bulletin IEB-26A.—Aeroquip Corp., Jackson, Michigan.

Circle **705** on inquiry card.

THINWALL TEFLON TUBING is described and illustrated in new 4-page Catalog T-2001.—Halogen Insulator and Seal Corp., 10121 Franklin Ave., Franklin Park, Ill.

Circle **706** on inquiry card.

EXTRUDED TEFLON TUBING for insulation in a continuous service at temperatures up to 250° C is tabulated on 2-page specification sheet.—L. Frank Markel & Sons, Morristown, Pa.

Circle **707** on inquiry card.

ITV

CAMERA AND ATTACHMENTS. Maker's remote lens iris-focus control assembly is subject of new 2-page Bulletin 6-24.—Kin Tel, (Kay Lab.), Box 623, San Diego 12, Calif.

Circle **708** on inquiry card.

INDUSTRIAL TELEVISION equipment covering cameras, monitors, accessories, etc., is summarized in new 7-page Quick Reference Catalog.—Allen B. Du Mont Laboratories, Inc., Bloomfield Ave., Clifton, N. J.

Circle **709** on inquiry card.

ITV. "Intra-Tel" ITV equipment is described and illustrated in the new 12-page Brochure ECL-53.—General Electric Co., Electronics Park, Syracuse, N. Y.

Circle **710** on inquiry card.

ITV SYSTEMS. New 4-page catalog describes ITV boosters, converters, amplifiers and accessories.—Blonder-Tongue Labs., Inc., Newark 2, N. J.

Circle **711** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

JONES BRIDGE for electrolytic conductivity measurements is described in new 2-page Data Sheet E-95(2).—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **712** on inquiry card.

ELECTRONIC INSTRUMENTATION. Oscilloscopes, identical X- and Y-amplifiers, pre-amplifiers and pulse generators VTVM's in the new 400 Series are illustrated in new 4-page Form 3547.—Allen B. DuMont Labs., Clifton, N. J.

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ALL TRANSITOR AMPLIFIER for use in analog computation and amplification of low level d-c signals is described in new 4-page Bulletin 3003.—Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif.

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ELECTRONIC INSTRUMENTS. "Eput" meters, expanded scale volt and frequency meters, transformation ratio meters, resistance bridges, nuclear scalers, recorders and readouts, and the "Ease" 1100 analog computer with digital input and output, are the subject of new 8-page Short Form Catalog C-704.—Beckman/Berkeley Div., 2200 Wright Ave., Richmond, Calif.

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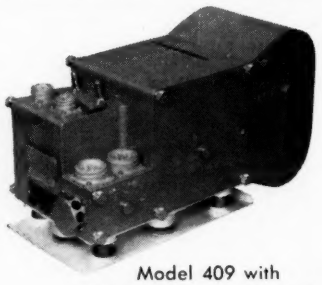

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NEW LITERATURE

STANDARD AND NULL METER. New 2-page Bulletin 13-3 describes Model 301 DC Standard and Null Meter. Microvolt-ammeter, Model 203AR is the subject of new 2-page Bulletin 16-3. —KIN TEL, 5725 Kearny Villa Road, San Diego, Calif.
Circle **716** on inquiry card.

SERVOMOTOR-RATE GENERATOR Model 11MG 460/460 size 11, 115-volt, 400-cycle is described in new 2-page Data Sheet 872.—Helipot Technical Information Service, Newport Beach, Calif.
Circle **717** on inquiry card.

PHASE ANGLE VOLTMETERS. Measurement of magnitude and phase of a signal in addition to other electronic test functions are described in 2-page Bulletin GBA-2624.—North Atlantic Industries, Inc., 603 Main St., Westbury, L. I., N. Y.
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STRAIN GAGE BRIDGE "B-1," powerline operated, is described and illustrated in new Bulletin 13.—Ellis Associates, Box 77, Pelham, N. Y.
Circle **719** on inquiry card.

PULSE CALIBRATOR Type 1810 for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time is described in new 4-page brochure.—Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Phila. 7, Pa.
Circle **720** on inquiry card.

AMPLIFIER SYSTEM. Model 1054, seven-channel, a-c voltage wide band instrument, is described in new 2-page bulletin.—Dynamics Instrumentation Co., Div. of Alberhill Corp., 1118 Mission St., S. Pasadena, Calif.
Circle **721** on inquiry card.

ELECTRONIC INSTRUMENTS. Counters, magnets, motors, relays, timers, etc., are catalogued in 16-page issue of "This Month."—Herbach & Rademan, Inc., 1204 Arch St., Phila. 7, Pa.
Circle **722** on inquiry card.

ULTRASONIC GENERATOR. Makers ultrasonic generator Model 2025 is described in 2-page leaflet just released. —Alcar Instruments Inc., 17 Industrial Ave., Little Ferry, N. J.
Circle **723** on inquiry card.

VOLTAGE ADJUSTORS manually adjusted transformers, designed to step-up low voltage or step-down high voltage are described in new 4-page Bulletin VA 312.—New 4-page Bulletin SD 311 lists stock sizes of step-down transformers with specifications and dimensions.—Acme Electric Corp., Cuba, N. Y.
Circle **724** on inquiry card.

CONTROL CENTERS as used in electric motor control and power distribution are described in new 16-page manual.—Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.
Circle **725** on inquiry card.

TRANSISTORIZED INVERTERS. Frequency stability, effects of altitude, temperature and vibration, efficiency, operation theory and wave shape, overload and regulation of transistorized inverters are the subject of new 8-page brochure.—Electrosolids Corp., 7436 Varna Ave., N. Hollywood, Calif.

Circle **726** on inquiry card.

MEGOHMMETER which measures insulation resistance in megohms and measures insulation leakage in picomhos, is illustrated in 4-page Bulletin 1035A. New 4-page Bulletin 1047A describes Model 47A Milliohmmeter which employs a-c test currents at line voltage frequency.—Hermann H. Sticht Company Inc., 27 Park Pl., New York 7, N. Y.

Circle **727** on inquiry card.

TEST EQUIPMENT. Maker's antenna line tester, transistor-check, in-circuit condenser tester, speaker substituter and other products are detailed in new 6-page bulletin.—Century Electronics Co. Inc., 111 Roosevelt Ave., Mineola, N. Y.

Circle **728** on inquiry card.

AUTOMATIC VOLTAGE REGULATORS —type EM10009 is described in new release SE-L3579.—Type IEH 5101 for high-frequency applications is contained in 2-page leaflet SE-L3571. —Type TM7105 providing maintenance-free automatic voltage regulation is specified in new release SE-L2579.—The Superior Electric Co., Bristol, Conn.

Circle **729** on inquiry card.

DIGITAL VOLTMETERS (and other) measuring equipment are described in maker's new 28-page Catalog 357.—Non-Linear Systems, Inc., San Diego County Airport, Del Mar, Calif.

Circle **730** on inquiry card.

SWITCHES, RELAYS

MULTI-CONTACT RELAY of miniature size with bid relay reliability is described in 4-page bulletin.—Phillips Control Corp., 59 W. Washington St., Joliet, Ill.

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FOOT SWITCH (Smith Switch) is fully described and illustrated in new catalog sheet.—Chicago Telephone of California, Inc., 105 Pasadena Ave., South Pasadena, Calif.

Circle **732** on inquiry card.

SWITCHES. New 4-page bulletin describes complete line of indoor and outdoor time control switches.—Paragon Electric Co., Two Rivers, Wisc.

Circle **733** on inquiry card.

SOLENOIDS adaptable to industrial applications, with complete specifications, are contained in new 4-page bulletin.—W. L. McMichael, Inc., 1428 W. Hillgrove Ave., Western Springs, Ill.

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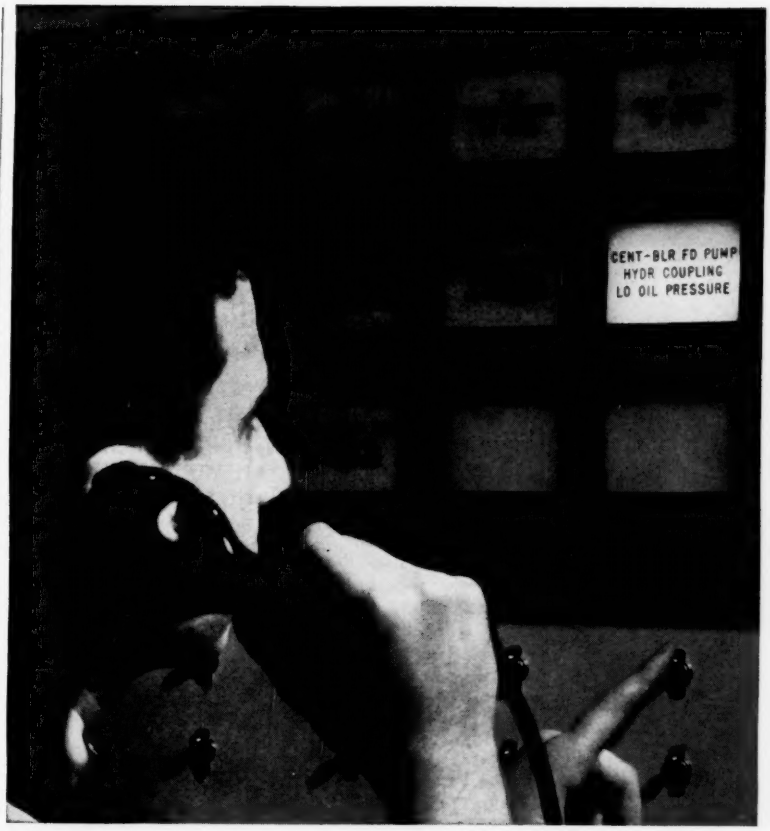

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In the process industries and among users of automatic machinery, trouble is minimized when it's caught early. That's the purpose of the Panalarm Annunciator System—a continuous monitor of your process.

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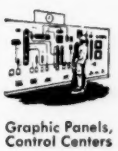
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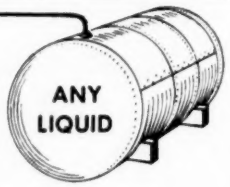

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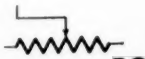
NEW LITERATURE

MERCURY PLUNGER RELAYS are described in new 8-page Catalog 157.—Ebert Electronics Corp., Queens Village 28, N. Y.
Circle **735** on inquiry card.

SNAP-ACTION SWITCHES, open-type S20-00A, S25-00A; double-pole type S35-00A, S36-00A; and standard type E10-00A, E15-00A, E16-00A; are described and illustrated in 2 new 4-page bulletins, and 2-page bulletin, respectively.—Cherry Electric Prods. Corp., 1650 Deerfield Rd., Highland Park, Ill.
Circle **736** on inquiry card.



RESISTORS, POTENTIOMETERS

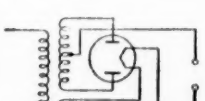
CARBON FILM RESISTORS ceramic encased for use in test equipment, meters and hi-frequency circuits are described in new data sheet 307-1056.—Continental Carbon, 13900 Lorain Ave., Cleveland 11, Ohio.
Circle **737** on inquiry card.

POTENTIOMETERS. Series "HP-200" (2" dia.) and series "HP-500" (5" dia.) are covered in two new 2-page bulletins.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.
Circle **738** on inquiry card.

POTENTIOMETER that meets problems of range, space, humidity, vibration, and temperature is described and illustrated in 4-page Bulletin C565.—Con Elco, 1711 S. Mountain Ave., Box 307, Monrovia, Calif.
Circle **739** on inquiry card.

RESISTORS. Dimensions, resistance values and prices of new molded composition resistors only 0.067" in diameter and 0.140" long are covered in Bulletin 150—Ohmite Mfg. Co., 3650 Howard St., Skokie, Ill.
Circle **740** on inquiry card.

VERNIER POTENTIOMETER Type 29-A "Verni-Pot" is described in new 2-page Bulletin F143.—Research Instrument Corp., 7962 S. E. Powell Blvd., Portland 6, Ore.
Circle **741** on inquiry card.



POWER SUPPLIES

POWER SUPPLIES, Semi-conductor voltage-regulated and magnetic-amplifier voltage-regulated types and semi-conductor DC to DC converters, are covered in new 4-page Brochure B576.—Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y.
Circle **742** on inquiry card.

D-C. POWER SUPPLIES, electronically regulated, constant voltage 200-325 vdc, 0-100 ma, are specified in new 2-page bulletin.—Associated Specialties Co., 1751 Main St., Orefield, Pa.
Circle **743** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

ELECTRICAL COMPONENTS. Maker's micropositioner, is the subject of 2-page issue of "Electrical Component News."—Barber-Colman Co., Rockford, Ill.
Circle **744** on inquiry card.

ASSEMBLY KITS. Instruction book containing tables of common gear ratios and moments of inertia is available as 8 page Booklet SBI-REV 1-557.—Servo Corp. of America, New Hyde Park, N. Y.
Circle **745** on inquiry card.

CAPACITORS. Subminiature "Tan-o-mite" series TW tantalum units, are detailed in new 6-page Bulletin 148B and 2-page Bulletin 148B Supplement.—Ohmite Manufacturing Co., Skokie, Ill.
Circle **746** on inquiry card.

VOLTAGE REGULATORS. Corona type, including glass and metal construction, performance curves, specifications, and applications, are contained in new 4-page Form 3003-7.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.
Circle **747** on inquiry card.

MINIATURE ELECTRICAL CONNECTORS. Miniature push-pull, rack, panel and edgelite and charts of contact clockings and alternate insert positions, are contained in new 20-page catalog.—The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.
Circle **748** on inquiry card.

CAPACITORS, oil filled or pyroteen for limited-space applications are covered in new 4-page Catalog 1134.—Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill.
Circle **749** on inquiry card.

CAPACITORS, d-c, aluminum electrolytic "Alumalytic" for radio, television and communications equipment are described in new 4-page Bulletin GEZ-1912.—General Electric Co., Schenectady 5, N. Y.
Circle **750** on inquiry card.

DELAY LINES are described and illustrated in 4-page Bulletin S-2.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.
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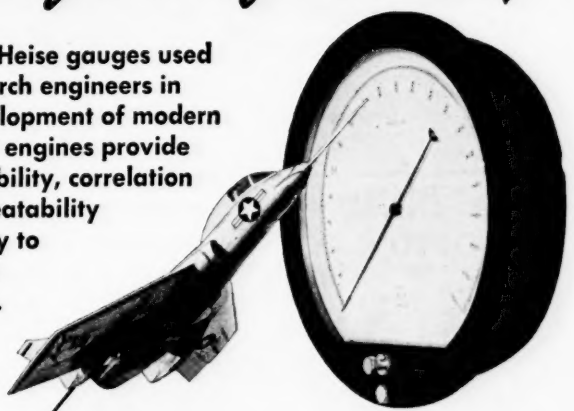

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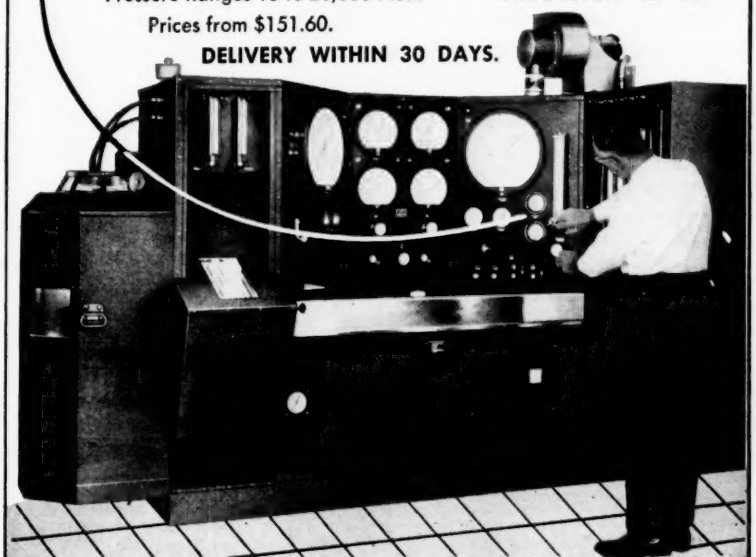

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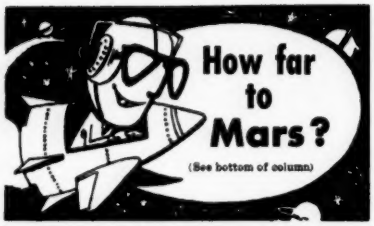

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MAGNETIC SHIELDS for cathode ray tubes and photomultiplier tubes are illustrated in Data Sheet 125.—Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

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COMPRESSION MULTI-HEADERS and plugs are described in new 16-page Catalog 657A.—Hermetic Seal Corp., Dept. IA, 29 S. 6th St., Newark 7, N. J.

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RESISTANCE WIRE, ribbon and furnace strip are illustrated in new 12-page Catalog M-55D.—Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.

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METAL STAMPINGS. New 12-page Catalog 573 describes beryllium copper components including contact strips and custom-built stampings.—H. Braun Tool and Instr. Co., 140 Fifth Ave., Hawthorne, N. J.

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WELD FASTENERS and stock parts are described and illustrated in 40-page Catalog 58.—The Ohio Nut & Bolt Co., 33 First Ave., Berea, Ohio.

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SPRINGS and small stampings in various metals are described in new booklet.—Superb Spring Works, Inc., 34 A East Sidney Ave., Mount Vernon, N. Y.

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Accuracy Scientific Instrument Co. 1600
Acoustica Associates, Inc. 1534
Aero Research Instrument Company, Inc. 1602
Aerotech Specialties Incorporated 1614
A'G'A Division of Elastic Stop Nut Corporation of America 1598
Allegany Instrument Co. Inc. 1539
All American Tool & Mfg. Co. 1595
American Chain & Cable Company 1585
American Meter Company 1595
AMP Incorporated 1441
Ampex Corporation 1527
Amphenol Electronics Corporation 1550
Amthor Testing Instrument Co., Inc. 1608
Analytical Measurements, Inc. 1565
Annin Company 1412-1413
Applied Science Corp. of Princeton 1618
Aquatic Research Inc. 1593
Atomic Power Development Associates, Inc. 1618
Automatic Switch Co. 1431

Bailey Meter Company 1450-1451
Baldwin-Lima-Hamilton Corporation 1461
Barber-Colman Company 1601
Barksdale Valves 1426
Barton Instrument Corporation 1553
Beggs & Son, Paul W. 1618
B & F Instruments, Inc. 1599
B-I-F Industries, Inc. 1607
Bird & Company, Richard H. 1536
Bishop & Co. Platinum Works, J. 1460
BJ Electronics, Borg-Warner Corporation 1574
Breeze Corporations, Inc. 1404
Bridgeport Thermostat Division 1555
Bristol Company 1452-1453, 1618
Brooks Rotameter Company 1575
Builders-Providence, Inc. 1607
Burgess Battery Company 1398
Burgess-Manning Company, Penn Instruments Division 1601

Century Electronics & Instruments, Inc. 1614
Chace Co., W. M. 1570
Chatillon & Sons, John 1572
Cobehn, Inc. 1616
Cohn Corp., Sigmund 1608
Columbia International Corp. 1603
Colvin Laboratories, Inc. 1560
Comar Electric Company 1596
Computer Instruments Corporation 1567
Conax Corporation 1598
Conoflow Corporation ..... Inside Front Cover
Consolidated Electrodynamics Corporation 1437, 1544, 1545
Crawford Fitting Company 1449, 1587
Crescent Insulated Wire & Cable Co. 1564
Crystal Glass Tube & Cylinder Co. 1584

Dahl Company, George W. 1548
Datex Division, G. M. Giannini & Co., Inc. 1463
Davis Instruments 1565
Daystrom Systems, Dviision of Daystrom, Inc. 1465
Derbyshire, Inc., F. W. 1436
Development Engineering Company 1428
Diamond Power Specialty Corp. 1613
Dimco-Gray Company 1600
Driver Co., Wilbur B. 1402
Dyna-Empire, Inc. 1612
Dynamic Instrument Company 1567

Eastern Air Devices, Inc. 1533
Edison Industries, Inc., Thomas A., Instruments Division 1439, 1583
Electric Auto-Lite Company 1473
ElectroData—Division of Burroughs Corporation 1401
Electronic Associates, Inc. 1514
Electronic Engineering Company of California 1566
Emery Company, A. H. 1531
EPIC, Inc. 1430
Eppley Laboratory, Inc. 1563
EPR Special Products Corp. 1597

Falstrom Company 1398
Farris Engineering Corporation 1405
Fielden Instrument Division 1547
Fischer & Porter Co. ..... Inside Back Cover
Fisher Governor Company 1454-1455
Foxboro Company 1410-1411, 1443, 1447
Franklin Electronics, Inc. 1604
Freed Transformer Co., Inc. 1591

General Electric Company 1440, 1448
General Precision Equipment Corporation 1406
General Precision Laboratory Incorporated 1407
General Transistor Corporation 1419
Genisco Incorporated 1470
Giannini & Co. Inc., G. M. 1579
Golden Anderson Valve Specialty Co. 1586
Goodyear Aircraft Corporation 1397
Gordon Co., Claud S. 1532
Gow-Mac Instrument Co. 1568
Graphic Systems 1582
Graton & Knight Company Inc. 1457

Hagen Manufacturing Company, Inc. 1428
Hammel-Dahl Company ..... Back Cover
Hankison Corporation 1558
Hays Corporation 1403
Heiland Instruments 1423
Heise Bourdon Tube Company, Inc. 1617
Helicoid Gage Division 1585
Hexacon Electric Company 1584
H. J. J. Company 1580
Hoke, Incorporated 1425
Hoke-Manostat Corporation 1576

Ideal Industries, Inc. 1560
Illinois Testing Laboratories, Inc. 1603
Industrial Instruments, Inc. 1556, 1557
Industrial Pyrometer and Supply Co. 1477
Instrument Motors 1593
International Business Machines Corporation 1490
International Optical Company, Inc. 1618

Jerguson Gage & Valve Company 1582
Johnson Engineering Company, Inc., Welton V. 1580
Jones Optical Works, A. D. 1573

Kearfott Company, Inc. 1408
Kurman Electric Co., Inc. 1607
Kybernetes Corporation 1529

Landis & Gyr, Inc. 1525
Leeds & Northrup Company 1474
Leslie Co. 1478
Levin & Son, Inc., Louis 1434
Lewis Engineering Co. 1414
Lewis Spring & Manufacturing Company 1619
Librascope, Inc. 1409
Lockheed Aircraft Corporation 1559
Lynn, Robert M. 1584, 1616

Magnetic Research Corp. 1605
Mallory & Co., Inc., P. R. 1462
Manning, Maxwell & Moore, Inc. 1420-1421, 1446, 1464
Marsh Instrument Co. 1602
Marshalltown Manufacturing Co. 1558
McDonnell Aircraft Corporation 1618
Measurements Corporation 1614
Mercoid Corporation 1603
Meriam Instrument Company 1551
Midwestern Instruments 1444-1445
Mine Safety Appliances Company 1433
Moeller Instrument Company 1568
Moore & Company, Samuel 1432
Moser Jewel Company 1602

Nash Engineering Company 1468
New Hermes Engraving Machine Corp. 1424
Newark Electric Company 1610
Ney Company, J. M. 1601
Norcross Corporation 1580
North American Van Lines, Inc. 1537

Offner Electronics 1538
Ohmite Manufacturing Company 1429
O. K. Machine & Tool Corporation 1592
Optics Manufacturing Corp. 1610
Opto-Metric Tools, Inc. 1597

Pace Engineering Company 1599
Palmer Thermometers, Inc. 1456, 1562
Panellit, Inc. 1615
Petrometer Corporation 1568
Philbrick Researches, Inc., George A. 1554
Phillips & Hiss Co., Inc. 1612
Plummer & Kershaw 1600
Potter & Brumfield, Inc. 1571
Potter Instrument Company, Inc. 1561
Precision Products Company Inc. of Waltham 1563
Precision Tube Company 1400
Preis Engraving Machine Co., H. P. 1612
Pritchard & Company of California, J. F. 1552

Racine & Company, Inc., Jules 1599
Radio Frequency Laboratories, Inc. 1542
Rahm Instruments, Inc. 1543
Railway Communications, Inc. 1611
Red Point Corporation 1598
Reeves Instrument Corp. 1422
Reeves Soundcraft Corp. 1471
Renick Co., L. C. 1608
Robbins Aviation 1582
Royal McBee Corp. 1472

Sanborn Company 1427
Scam Instrument Corporation 1575
Scherr Co., Inc., Geo. 1596
Sensitive Research Instrument Corporation 1398
Servo-Systems Company 1618
Shore Instrument & Mfg. Co., Inc. 1607
Skinner Electric Valve Division 1507
Slaughter Company 1618
Smith Co., S. Morgan 1609
Sorensen & Company, Inc. 1417
Southwestern Industrial Electronics Company 1606
Stackpole Carbon Co. 1563
Standard Instrument Corporation 1560
Statham Laboratories 1549
Sticht Co., Inc., Herman H. 1589, 1591
Streeter-Amet Company 1597
Stromberg-Carlson 1569
Superior Electric Company 1521
Superior Tube Company 1466
Swiss American Jewel Bearings Co. 1591

Technical Products Co. 1556
Technique Associates 1596
Telemeter Magnetics, Inc. 1435
Testa Manufacturing Company 1593
Thermco Laboratories 1586
Thermo Electric Co., Inc. 1590
Tigerman Engineering Company 1540
Trimount Instrument Company 1595
Trinity Equipment Corporation 1513

Uehling Instrument Co. 1616
Unertl Optical Co., John 1589
Union Switch & Signal Division of Westinghouse Air Brake Company 1535
United Electric Controls Company 1573
Universal General see Universal Relay Corp. 1589

Van Products Co. 1578
Vapor Recovery Systems Company 1588
Veeder-Root Incorporated 1442
Vulcan Rubber Products Division of Reeves Brothers Inc. 1528

Wallace & Tiernan Incorporated 1581
Waugh Engineering Company 1530
Weksler Thermometer Corp. 1573
West Coast Electrical Mfg. Corp. 1610
West Instrument Corporation 1577
Weston Electrical Instrument Corporation, a Subsidiary of Daystrom, Incorporated 1458-1459
Wiancko Engineering Company 1438
Wolverine Tube Division 1541
Worley Jewel Co., John 1586

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SOCKET SCREWS, pressure plugs, and dowel pins are reviewed in detail in the new 32-page Catalog 877.—Aldred W. Scott, Adv. Dept., Box 372, Standard Pressed Steel Co., Jenkintown, Pa.

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COPPER & COPPER ALLOYS. 26-page Publication B-34 lists alloys and other products with specifications of ASTM, ASME, AWS, SAE, AMS, Federal, Military, and JAN; and tabulates chemical compositions of Anaconda Metals covered by standard specifications.—The American Brass Co., Dept. RS, Waterbury 20, Conn.

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5	30	55	80	105	130	155	180	205
6	31	56	81	106	131	156	181	206
7	32	57	82	107	132	157	182	207
8	33	58	83	108	133	158	183	208
9	34	59	84	109	134	159	184	209
10	35	60	85	110	135	160	185	210
11	36	61	86	111	136	161	186	211
12	37	62	87	112	137	162	187	212
13	38	63	88	113	138	163	188	213
14	39	64	89	114	139	164	189	214
15	40	65	90	115	140	165	190	215
16	41	66	91	116	141	166	191	216
17	42	67	92	117	142	167	192	217
18	43	68	93	118	143	168	193	218
19	44	69	94	119	144	169	194	219
20	45	70	95	120	145	170	195	220
21	46	71	96	121	146	171	196	221
22	47	72	97	122	147	172	197	222
23	48	73	98	123	148	173	198	223
24	49	74	99	124	149	174	199	224
25	50	75	100	125	150	175	200	225

Show Preview					
326	351	376	401	426	
302	327	252	377	402	427
328	353	378	403		
304	329	354	379	404	
305	330	355	380	405	
306	331	356	381	406	
307	332	357	382	407	
308	333	358	383	408	
309	334	359	384	409	
310	335	360	385	410	
311	336	361	386	411	
312	337	362	387	412	
313	338	363	388	413	
314	339	364	389	414	
315	340	365	390	415	
316	341	366	391	416	
317	342	367	392	417	
318	343	368	393	418	
319	344	369	394	419	
320	345	370	395	420	
321	346	371	396	421	
322	347	372	397	422	
323	348	373	398	423	
324	349	374	399	424	
325	350	375	400	425	

New Instruments					
476	501	526	551	576	
452	477	502	527	552	577
478	503	528	553	578	
454	479	504	529	554	579
455	480	505	530	555	580
456	481	506	531	556	581
457	482	507	532	557	582
458	483	508	533	558	583
459	484	509	534	559	584
460	485	510	535	560	585
461	486	511	536	561	586
462	487	512	537	562	587
463	488	513	538	563	588
464	489	514	539	564	589
465	490	515	540	565	590
466	491	516	541	566	591
467	492	517	542	567	592
468	493	518	543	568	593
469	494	519	544	569	594
470	495	520	545	570	595
471	496	521	546	571	596
472	497	522	547	572	597
473	498	523	548	573	598
474	499	524	549	574	599
475	500	525	550	575	600

New Literature								
601	626	651	676	701	726	751	776	
602	627	652	677	702	727	752	777	
603	628	653	678	703	728	753	778	
604	629	654	679	704	729	754	779	
605	630	655	680	705	730	755	780	
606	631	656	681	706	731	756	781	
607	632	657	682	707	732	757	782	
608	633	658	683	708	733	758	783	
609	634	659	684	709	734	759	784	
610	635	660	685	710	735	760	785	
611	636	661	686	711	736	761	786	
612	637	662	687	712	737	762	787	
613	638	663	688	713	738	763	788	
614	639	664	689	714	739	764	789	
615	640	665	690	715	740	765	790	
616	641	666	691	716	741	766	791	
617	642	667	692	717	742	767	792	
618	643	668	693	718	743	768	793	
619	644	669	694	719	744	769	794	
620	645	670	695	720	745	770	795	
621	646	671	696	721	746	771		
622	647	672	697	722	747	772		
623	648	673	698	723	748	773		
624	649	674	699	724	749	774		
625	650	675	700	725	750	775		

NEW LITERATURE

PLASTIC CLAMPS and custom cables are subjects of (1) new 4-page bulletin giving information on ethyl cellulose clamps and (2) new 2-page bulletin describing the custom cables.—National Wire and Cable Corp., 136 San Fernando Rd., Los Angeles 31, Calif.

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FIBERGLAS-POLYESTER laminates termed superior to phenol laminates for Class A insulation are described in new 4-page pamphlet.—Owens-Corning Fiberglas Corp., Dept 860, 598 Madison Ave., New York 22, N. Y.

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FOTOFORM GLASS a new versatile material with important electrical, mechanical, and optical properties of particular interest to the electronic and allied fields is discussed in a new 8-page Bulletin EP-FFI-10M.—Corning Glass Works, Corning, N. Y.

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FILTER MATERIAL of new "Armalon" tetrafluoroethylene fibrous sheet is described in new Bulletin 6.—Room 7017-D, DuPont Company, Wilmington 98, Del.

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TEFLON FILM for insulation etc., available in continuous roll lengths of 100 and 500 feet and widths from ¼" to 1" in increments of 1/16", is described in new 4-page Brochure.—Dilectrix Corp., Allen Blvd. & Grand Ave., Farmingdale, L. I., N. Y.

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PLASTICS, including source materials for fiber glass reinforced plastics, is the subject of new 14-page catalog.—Cadillac Plastic & Chemical Co., 15111 2nd Ave., Detroit 3, Mich.

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INSULATING MATERIALS of types in Class A, Class B, and Class H, are discussed in new 8-page Booklet B-7206.—Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

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FABRICATION

ATMOSPHERE FURNACE. Ability to upgrade and protect metals in quality heat treating is the subject of new 8-page Bulletin SC-178.—Surface Combustion Corp., 2375 Door St., Toledo 1, Ohio.

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MOTOR-GENERATOR WELDERS, d-c, are described in new 4-page Bulletin GEC-1453.—General Electric Co., Schenectady 5, N. Y.

Circle **786** on inquiry card.

FABRICATED ALLOY STEEL items are illustrated in new 4-page folder.—Aluminum & Architectural Metals Co., 1947 Franklin St., Detroit 7, Mich.

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ELECTROLIZING a process that helps overcome friction, wear, abrasion, galling, and corrosion problems of wear parts is described in a new 24-page booklet.—The Electrolizing Corp., 1505 East End Ave., Chicago Heights, Ill.

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COOLING EQUIPMENT for electronic applications, is covered in new 8-page Catalog Sheet 10101-1A.—Rotron Mfg. Co., Schoonmaker La., Woodstock, N. Y.

Circle **789** on inquiry card.

AUTOMATIC DRILL UNITS, automatic drill heads, and small-diameter drill grinder are specified in new 24-page Catalog 55-D.—Dumore Precision Tools, 1300 17th St., Racine, Wis.

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ULTRASONIC BRAZING is described in new 4-page Bulletin SBR-6A, and Bulletin SB-6A gives information on maker's line of units for ultrasonic, fluxless soldering.—Aeroprojects Inc., West Chester, Pa.

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HIGH TENSION SEPARATOR design characteristics, power requirements, operation and application data are described in a new 2-page Bulletin HPB-103.—Carpco, Jacksonville, Fla.

Circle **792** on inquiry card.

INSTRUMENT DIVIDER HEAD for synchros, resolvers, resistance potentiometers, etc. is the subject of new 2-page bulletin.—Path Engineering & Machined Products, 1048 Pico Blvd., Santa Monica, Calif.

Circle **793** on inquiry card.

CLEANING TOOL for gage glasses is illustrated and described in new Data Sheet 301.—Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

Circle **794** on inquiry card.

SOLVENT APPLICATOR. One page release describes solvent applicator Model 120, designed to apply correct amount of solvent to nameplates.—Park Nameplate Co. Inc., 34-10 Linden Place, Flushing 54, New York, N. Y.

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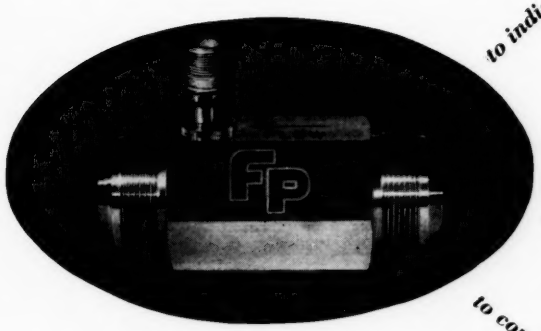
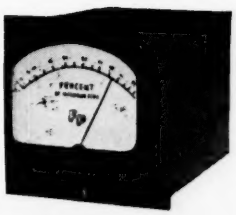


to indicate flow

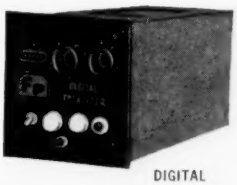


PANEL FLOW RATE INDICATOR

to indicate steady state flow condition

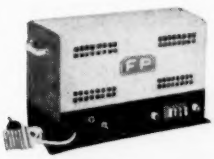
IN-LINE DIGITAL INDICATOR

to totalize flow for batch processes



DIGITAL TOTALIZER

to convert transient flow for analog output



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get flow information in any form you need it

. . . with F&P turbine meters and readout devices

Here's the ideal solution to flow metering problems characterized by high temperature, high pressure, high flow volume, or rapid flow transients. Fischer & Porter turbine meters are inherently among the most accurate flow measuring devices available today . . . providing measurements accurate to ½% of instantaneous rates.

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PANEL FLOW RATE INDICATOR: Provides scale reading in desired flow units or in percentage of maximum flow. Includes amplifier which may be used to feed EPUT meters or integrators, and analog converter.

"IN-LINE" DIGITAL INDICATOR: Direct digital readout of flow information in desired gravimetric or volumetric units. Automatically selects turbine meter outputs by flow range.

DIGITAL TOTALIZER: Provides integrated flow information accurate to ½%.

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For complete data on the F&P turbine meter and some of the systems it makes possible, write for catalog. Address request to Fischer & Porter Co., 387 County Line Road, Hatboro, Penna.

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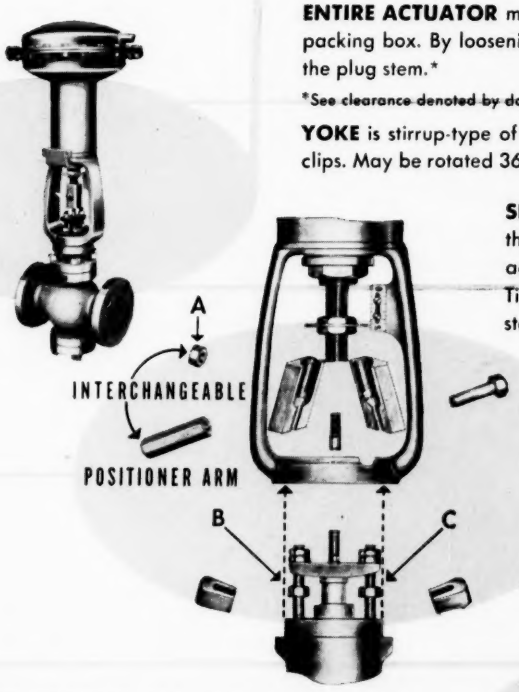
KEYNOTE

OF THE NEW H-D ACTUATOR



ENTIRE ACTUATOR may be removed and replaced without disturbing the packing box. By loosening nuts A, B, and C the actuator may be lifted over the plug stem.*

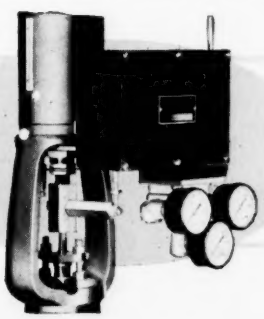
*See clearance denoted by dotted lines and arrows.

YOKE is stirrup-type of cast nodular iron. Held to bonnet by **stainless steel** clips. May be rotated 360° on bonnet.

SPLIT COUPLING has L.H. (upper) and R.H. (lower) threads. Stems do not engage—do not meet. Coupling acts as a turnbuckle for adjusting plug seating tension. Tightly clamped coupling prevents twisting of plug stem.

SLOTTED HOLDING CLIPS permit removal of clips without removing nuts B and C.

SPRINGS are available in three interchangeable ranges, 3-15, 5-25, and 6-30 psi. Interchangeable in any actuator — no additional parts required.



POSITIONER BRACKET (Universal) supplied on all valves for the mounting of any positioner. No valve disassembly required — Positioner can be mounted in the field by removing nut A and replacing it with the positioner arm.

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